REPORT

NORTH CAROLINA EXPERIMENT STATION

1887

TENTH ANNUAL REPORT

OF THE

NORTH CAROLINA

Agricultural Experiment Station,

FOR 1887.

November 13, 1888.

RALEIGH, N. C.:
JOSEPHUS DANIELS, STATE PRINTER AND BINDER.
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1888.

Office of the North Carolina
Agricultural Experiment Station,
Raleigh, N. C., August 1, 1888.

To Governor A. M. Scales,
Chairman of the Board of Agriculture:

Sir:—I have the honor to submit herewith the Annual Report of the North Carolina Agricultural Experiment Station for the year 1887. It embraces the period during which my predecessor was in charge, up to September 1st, 1887; as well as the remainder of the year when the Station was under my immediate direction. I hope that the delay in publication, which has been unavoidable, will not detract from whatever value the Report may have for the future.

Trusting that it will prove satisfactory to your Excellency and the Board of Agriculture,

I am, respectfully yours,

H. B. Battle,
Director.

NORTH CAROLINA

STATE BOARD OF AGRICULTURE.

1887.

GOVERNOR ALFRED M. SCALES, (*ex officio*) CHAIRMAN.

W. R. WILLIAMS, ESQ.	Master State Grange Patrons of Husbandry.
COL. R. W. WHARTON	First Congressional District.
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JOHN ROBINSON, ESQ. (to April)	Sixth Congressional District.
CAPT. S. B. ALEXANDER (after April)	Sixth Congressional District.
A. LEAZAR, ESQ	Seventh Congressional District.
BURWELL BLANTON, ESQ	Eighth Congressional District.
DR. C. D. SMITH	Ninth Congressional District.

OFFICERS:

MONTFORD MCGEHEE	Commissioner to April, 1887.
JOHN ROBINSON	Commissioner after April.
T. K. BRUNER	Secretary.
C. W. DABNEY, JR., (to Sept. 1, '87) H. B. BATTLE, (In charge after Sept)	Chemist and Director Exp. Station.
J. T. PATRICK	General Agent Immigration.

THE NORTH CAROLINA

Agricultural Experiment and Fertilizer Control Station.

ESTABLISHED IN 1877.

HAS FOR ITS SCOPE:

I. Chemical and Microscopical Work, including

1. The analysis of all fertilizers legally on sale in the State.
2. The analysis of agricultural chemicals, of composts, and home-made fertilizers, and all materials from which they can be made.
3. The analysis of soils, marls and mucks.
4. The analysis of feeding stuffs.
5. The analysis of potable and mineral waters.
6. The examination of seeds with reference to their purity, and capacity to germinate.
7. The examination of grasses and weeds.
8. The study of insects injurious to vegetation.
9. The analysis of milk, butter and other dairy products.
10. Such other chemical and microscopical investigation as is demanded in the experimental work of the Station.

II. Experimental Work in the Field, Stable, and Laboratory, to include

1. The effect of different fertilizers on various soils of the State.
2. The study of improved methods for cultivation of staple crops.
3. The study of the best treatment for worn-out lands.
4. The study of the best system for the rotation of crops.
5. Chemical investigations, with practical experiments with cattle, on the value of the various forage crops.
6. Investigations on the growth of new crops for this climate, in comparison with those we now have.
7. The construction of the silo, and value of ensilage.
8. The study of the growth of cattle using the different feeding stuffs.
9. Investigations in the production of milk, and butter under different conditions, and with various implements.
10. Digestion experiments with stock, to ascertain the value of various food stuffs.
11. Experiments with the various feeding rations to ascertain how far the feeding standards can be relied on.
12. Such other work from time to time as may be deemed advisable for the interests of the Agriculture of the State.

III. The Collection and Distribution of Meteorological Data, such as will directly aid the various agricultural industries of the State. This is done through the medium of the State Weather Service (which is now and has been a part of the Station) acting in conjunction with the United States Signal Service. The work is expected to be of benefit in

1. A foreknowledge of coming of cold waves, protecting fruit and tobacco interests.
2. A foreknowledge of the coming of frosts, to be of benefit in the same way.
3. The distribution of telegrams of weather indications transmitted in advance.
4. The collection of various meteorological data, in obtaining a more perfect idea of the various climatic changes; and thus in extending the crops now found useful in one section to other portions of the State.
5. The collection and distribution of reports showing the effect of the weather on the crops during successive periods of their growth.

IV. A Bureau of Information for all subjects connected with the agricultural industries of the State. Information of this character given as promptly and carefully as possible.

SAMPLES for examination will be accepted and analyzed

1. If they are taken strictly according to our printed forms, which must be obtained.
2. If they are of sufficient public interest.
3. If the Station is free to publish the results.

VISITORS will be gladly welcomed at

1. Offices, laboratories, and weather station, in the Agricultural Building, one block north of the State Capitol.
2. Farm, experimental stables and dairy, and plant house, on the Hillsboro road, 1½ miles west of the State Capitol, and adjoining the grounds of the State Agricultural Society, and of the Agricultural and Mechanical College.

Both the laboratories and the farm have telephonic communication.

Publications will be sent to any address upon application.

Address DR. H. B. BATTLE, *Director*, RALEIGH, N. C.

NORTH CAROLINA

Agricultural Experiment and Fertilizer Control Station.

OFFICERS:

DIRECTOR:

CHAS. W. DABNEY, Jr., Ph. D., (Resigned Sept. 1, 1887.)

H. B. BATTLE, Ph. D., (In charge after Sept. 1, 1887.)

SUPERINTENDENT OF FARM:

MILTON WHITNEY.

ASSISTANT CHEMISTS:

BALDUIN von HERFF, Ph. D.,

FRANK B. DANCY, A. B.,

W. A. WITHERS, A. M.

METEOROLOGIST:

H. McP. BALDWIN, U. S. Signal Corps.

Laboratory and Offices, Corner of Edenton and Halifax Streets, Raleigh; Farm, Plant House, Experimental Barn and Dairy, 1½ miles west on the Hillsboro Road.

The Experiment Station, by legislative enactment of 1887, receives the benefit of all funds derived from the Hatch Act; the scope of work is thereby largely increased.

VISITORS CORDIALLY INVITED AND ALWAYS WELCOMED.

PUBLICATIONS

OF THE

NORTH CAROLINA EXPERIMENT STATION,

1878 to 1888.

This list includes reports and special publications, but excludes all circulars, directions and forms. The Station has been regularly represented by articles in the *Monthly Bulletin* of the Department of Agriculture during the whole of its publication. Unless marked otherwise, they are unbound.

The following were issued under the Directorship of Dr. Albert R. Ledoux:

Directions for making Vinegar, 1878, 4 pages;

Analyses and Valuations of Fertilizers, 1877-'78, 30 pages;

Ville's formulæ for composting, and others furnished by Dr. Ledoux, 1878, 16 pages;

The Sugar Beet in North Carolina, 1878, 50 pages;

Silica vs. Ammonia, results of comparative soil-tests of Popplein's Silicated Phosphate, with a number of ammoniated guanos, 1878. 24 pages;

Analyses and Valuations of Fertilizers for 1877 and 1878, republished, 1879, 16 pages;

Report of the Director to the Legislature, January, 1879, Document No. 8, 16 pages;

Analyses and Valuations of Fertilizers for 1879, 8 pages;

Formulæ for Composting, 1879, 16 pages;

Report of the Station for 1879 (bound), 193 pages;

Report of the Station for 1880, including Analyses of Fertilizers for that year (bound), 148 pages;

The following were issued under the Directorship of Dr. Charles W. Dabney, Jr.:

Report to the Legislature, January, 1881, 16 pages;

Analyses of Drinking Waters, Bulletin for January, 1881;

Value of Active Ingredients of Fertilizers, Bulletin for February, 1881;

The Use of Agricultural Chemicals, Bulletin for March, 1881;

Analyses and Valuations of Fertilizers and Chemicals, 1881, 16 pages;

Adulterated Chemicals, Bulletin for July, 1881;

Analyses and Valuations of Fertilizers, 2d edition, 1881, 12 pages;

Report of the Station for 1881 (bound), 172 pages;

Trade in Fertilizers—Extension in Cotton Culture, Bulletin for January, 1882;

Home-made Manures—High-manuring on Cotton, Bulletin for February, 1882;

Does Cotton Exhaust? Cotton Seed and its Uses, Bulletin for March, 1882;

Stable Manure Saved and Composted—Rice products as a Feeding-stuff, Bulletin for April, 1882 ;

Analyses of Fertilizers, 1882, 8 pages ;

Analyses of Fertilizers, 2d edition, 1882, 12 pages ;

Experience with Home-made Manures, Bulletin for June, 1882 ;

Report of Work done for the State Board of Health, 1881, 8 pages ;

Treatment of Cotton Lands—Station at State Fair, Bulletin for October, 1882 ;

Report of the Station, 1882 (bound), 152 pages ;

Horn, Leather and Wool-Waste, and the Fertilizers made from them, 1882, 10 pages ;

Finely-ground Phosphates or "Floats," 1882, 10 pages ;

On Kainite, 1882, 28 pages ;

Rice and its Products—Food and Fodder Plants, Bulletin, May, 1882 ;

The Soja Bean—Waste Products of Tobacco Factories, Bulletin, May, 1883 ;

Analyses of Fertilizers, 1883, 16 pages ;

Analyses of Fertilizers, 2d edition, 1883, 16 pages ;

Cotton Seed and its Products, Bulletin, June, 1883 ;

N. C. Resources for Commercial Fertilizers,

I. Ammoniates ;

II. Potash Sources, Bulletin, December, 1883 ;

III. Phosphates, Bulletin, January, 1884 ;

The Trade in Fertilizers during 1883, 12 pages ;

Cost of the Ingredients of Fertilizers, Bulletin, February, 1884 ;

The Phosphate Investigation, Bulletin, March, 1884 ;

Analyses of Fertilizers, season of 1884, 16 pages ;

Composition of North Carolina Phosphates, Bulletin, April, 1884 ;

North Carolina Phosphates, report on, 26 pages ;

Report of Station, 1883 (bound), 104 pages ;

Analyses of Fertilizers, season of 1885, 16 pages ;

Analyses of Fertilizers, 2d edition ;

Report of Station, 1884 (bound), 104 pages ;

Analyses of Fertilizers, additional, Fall 1885, a circular, 2 pages ;

Analyses of Composts, etc., a Bulletin, 2 pages ;

Injurious Insects and Diseases of Stock, a Bulletin, 2 pages ;

Report of Station, 1885 (bound), 112 pages, 3 charts ;

Instructions for Voluntary Observers and Displaymen, 24 pages ;

Report of Station, 1886 (bound), 130 pages, 3 plates.

The following were issued by Dr. H. B. Battle :

Formulæ for Composts, Sept., 1887, 4 pages ;

Report of N. C. Weather Service for 1887, 37 pages ;

Composts and Ingredients Composing Them, 24 pages ;

Report of Experiment Station for 1887 (bound), 225 pages, 1 chart, 2 plates.

CONTENTS.

REPORT OF THE DIRECTOR

OF THE

AGRICULTURAL EXPERIMENT STATION,

FOR

1887.

INTRODUCTION.

The year 1877 was an eventful one in the history of North Carolina. It marked an era in the advancement of the agricultural interests of the State; in the advancement of the occupation in which three-fourths of her people are engaged.

On the 12th day of March of that year, there was enacted a law by the General Assembly which created a "Department of Agriculture, Immigration and Statistics, and for the Encouragement of Sheep Husbandry." So great was the demand on the part of prominent citizens for an institution of this character, that on the very day of the ratification of this act, the Board of Agriculture, as specified by the act, met in the City of Raleigh and completed the organization of the Department. The Governor of the State, the President of the University, the President of the State Agricultural Society, the State Geologist, the Master of the State Grange Patrons of Husbandry, as *ex-officio* members, and two other prominent agriculturists elected by them, constituted the first Board of Agriculture. Upon them devolved the labor of establishing, in compliance with the act, as a part of the Department of Agriculture, an Agricultural Experiment and Fertilizer Control Station, the *first* in the Southern States, and the *second* in America.

The objects for which the establishment of the Station was desired at that time were two-fold:

1st. To protect the farmers of the State from the fraudu-

lent fertilizers then flooding the market, by requiring every manufacturer doing business in the State to take out a license on each brand on sale by him; to exercise a general control of the trade by a system of inspecting all brands legally on sale in the State, and by a chemical analysis of these brands to ascertain if their qualities were maintained at a certain guaranteed standard.

2d. To carry on experiments in the field (in the language of the act) "on the nutrition and growth of plants with a view to ascertain what fertilizers are best suited to the various crops of this State, and whether other crops may not be advantageously grown on its soil."

Besides these two principal objects, the new institution was designed to be a bureau of information on all subjects pertaining to agriculture, where farmers and others could seek information in regard to farming or any of its allied branches. Where seeds, marls, soils, composts or any fertilizing ingredient could be examined and their quality determined. Where feeding stuffs could be analyzed and their value ascertained. Where insects, injurious to vegetation, could be studied and remedies recommended. Where varieties of cultivated plants could be tested. Where seeds could be examined with reference to their purity and capacity to germinate. Where farmers could obtain special information on subjects, which by reason of their limited libraries, they could not obtain for themselves.

The first decade in the life and growth of the Experiment Station has been completed. It will not then seem amiss, at this time, to give a brief history and outline of the work accomplished, and the benefit it has been to that class for which it was established, and for whose best interests those in charge have, at all times, endeavored to carry on the work.

The Experiment Station commenced operations at Chapel Hill, in connection with the State University, with Dr. A. R. Ledoux as its first Director, on April 19th, 1877. The

first analysis of a fertilizer ever made in the State was completed on May 8th. The first recorded paper was one on composting and compost formulas. Mr. W. B. Phillips was elected an Assistant Chemist in June, 1877, and continued to serve in that capacity till October, 1882. Mr. J. C. Taylor commenced work in September, 1878, and continued with the Station till January, 1881. Mr. George Warnecke remained with the Station from September, 1878, to November, 1879. At his resignation, Mr. Wilhelm Mager was appointed in his place, and remained till July, 1880. Mr. A. D. Mickle assumed charge of the records of the chemical work and conducted the clerical labors of the office from October, 1878, till July, 1883. Dr. Ledoux resigned the Directorship in November, 1880, and Dr. C. W. Dabney, Jr., was elected to fill the vacancy. In January, 1881, Mr. H. B. Battle commenced work as Assistant Chemist. Mr. Wm. F. Brugman remained with the Station from January, 1881, to August, 1881.

In the summer of 1881, the Station was removed to Raleigh where it occupied large and commodious quarters in the Agricultural Department Building, recently purchased for the use of the various branches of the Department. At this time the facilities for work were greatly increased, fully equipped laboratories were supplied, and offices were arranged on a more permanent basis. The Station continues to occupy these quarters.

In January, 1882, Mr. F. B. Dancy commenced work at the Station, and is still in its employ. Dr. B. von Herff remained at the Station from January, 1883, to April, 1887. Mr. W. A. Withers came to the Station in January, 1884, and is still connected with it. On the 1st of September, 1887, Dr. Dabney resigned his position, and the present Director has had charge since that time.

In April, 1886, a farm was added to the agencies of the Experiment Station, to carry out what had been in contemplation from the beginning, namely, the institution of ex-

perimental work in the field and in the plant house. Mr. Milton Whitney was elected its first Superintendent, and continued in that position till December, 1887.

In December, 1886, the State Weather Service, operating in conjunction with the U. S. Signal Service, was established in connection with the Experiment Station, and is now engaged in the collection of meteorological statistics, and in the dissemination of weather indications, cold wave and frost warnings.

The first decade of the life of the Station has been devoted, for the most part, to the development of the fertilizer question, in the control of commercial fertilizers, the discovery and best manner of using natural fertilizers (marls, phosphates, &c.,) and to the education of our farmers about farm manures and the best manner of saving, composting, mixing and using them. This was the work which was most needed, and has, we hope, proven of practical value to our people.

The analyses in the laboratory during the successive years of the decade have increased many fold. In the first year of its existence one hundred and twenty analyses were made; in the ninth year five hundred and fifty. During these ten years four thousand two hundred and fifty-seven analyses were completed, and were for each legislative period of two years, as follows:

April, '77, to January, '79,	249
January, '79, to January, '81,	760
January, '81, to January, '83,	909
January, '83, to January, '85,	1,095
January, '85, to January, '87,	1,077
January 1st, '87, to April 20th, '87,	167
Total	4,257

This work is classified as follows:

Commercial Fertilizers	1,556
Composts	46
Marls	324
Phosphates	248
Soils	353
Potash Salts	28
Cotton Seed Products	40
Chemicals for composting	157
Grasses and Seeds identified	108
Health analyses	51
Feeding stuffs	39
Minerals identified	572
Ores assayed	38
Drinking waters	283
Mineral waters	233
Coals	28
Sugar Beets	62
Miscellaneous	91
April, '77, to April, '87,	4,257

The money value of this analytical work cannot be estimated. By reference to the above list it can be seen that 1,600 samples of commercial fertilizers (including composts) have been analyzed. For this work, at the lowest calculation, a professional chemist would charge $20.00 for each analysis. In many cases $25.00 would have to be paid. Take the lowest limit, $20.00, for each of the sixteen hundred analyses, the total would be thirty-two thousand ($32,000) dollars. And this for the work on the fertilizers alone! There have been besides nearly three thousand other samples, all of which, in the work connected with the analysis, require the greatest care, time, skill and experience.

The volume of the correspondence of the Station during this time has been immense. Our official letters written during this time, containing only important letters of record, fill 15 volumes of 500 pages each, or 7,500 pages, containing about 8,250 letters, or, which indicates better the extent of the correspondence, our letters received fill 23 volumes of

500 pages each, which makes about 13,800 letters received and answered. This excludes letters received about the phosphate survey, requests for the bulletin and reports, bills and analyses since analysis No. 3,000. The letters about the analyses, always one, and generally more, are filed in each analysis. This will give at least 2,000 additional letters.

Our published pamphlets number 58, and make up 1,710 pages. Of these from 500 to 10,000 copies each were published and distributed.

As to whether the Experiment Station has been of benefit to the farmers and others of the State, the following brief statements will show:

1. Prior to 1887, no less than one hundred and twenty-five brands of fertilizers were sold in the State, and of such a character that no confidence could be placed in them or their qualities. A good fertilizer producing excellent crops the first year, might prove worthless the next. The farmers had absolutely no redress. On every hand fraudulent fertilizers were sold and no farmer could, by any possible means tell, before he had used them, whether they contained fifty or seventy-five per cent. of sand. The people had lost all confidence in their sale, and at the time of the establishment of the Experiment Station, scarcely 40,000 tons were sold annually, not from the fact that all fertilizers were made at home, but owing to the entire loss of confidence every one had in the trade. What were the people to do? The use of fertilizers of some kind for plant food on most of our lands is as necessary to the growth of the crop as food is to a baby.

They must be used, and yet the farmers of the year 1877 and before, were paying millions of dollars annually for sand to haul on the soil, in many instances already too sandy. In fact, a certain manufacturer sold many tons of a stuff containing the elements of common sand, which he claimed was as good as ammonia, and the farmers paid him eight cents per pound for it, because they had no means for proving that it was valueless.

2. After the law went into force, eighty out of these one hundred and twenty-five brands of fertilizers were driven from the State, and the remainder were greatly improved in quality, and have continued to improve ever since The following extract from the Station's Report for 1886 will give some idea of the improvement of the fertilizers sold.

The average per cent. of available phosphoric acid has increased from 7.40 in 1880, to 8.69 in 1886; the average per cent. of potash has increased from 1.30 in 1880, to 2.30 in 1886, while the per cent. of ammonia remains remarkably near one figure for all the years except 1883, when ammoniates were unusually scarce. Thus the valuation of the average fertilizer, using the prices of 1886 for all analyses alike, has, with a few fluctuations, steadily climbed from $21.04 per ton in 1880 to $24.52 per ton in 1885, and $23.44 in 1886. The most remarkable thing is, that during this period, 1880 to 1886, the actual cash prices paid by North Carolina farmers for these fertilizers has decreased twenty-five per cent., while the quality or grade has improved fourteen per cent. This means that North Carolina farmers could get, in 1886, for three millions of dollars what they had to pay four millions for in 1880—yes, and get an article one-seventh better than the 1880 article.

3. The Station, in endeavoring to extend information on all matters pertaining to scientific agriculture, has printed numerous publications, over sixty separate reports, pamphlets, formulas for composts, tables of analyses of fertilizers, &c. Nearly two hundred thousand of these publications have been distributed broadcast throughout the State, and in addition the monthly Bulletin has largely increased this circulation. These publications have been of the greatest service to the people of the State, individually and collectively.

4. By the Station's urgent advice, thousands of home-made composts have been made by farmers in every section of the State, and the farmers have learned that every pound of

compost put up means so much money in their pockets. To further aid in the work, these composts have been, when requested, analyzed by the Station. Over three hundred of these, and other home materials from waste products, have been examined and their value to the farmer shown.

5. The phosphate beds of the State have been explored and mapped. These beds, though not now worked on account of the existence of South Carolina rock of higher grade, will undoubtedly prove valuable in the future and thus be very profitable to the State.

6. The marls of the State have been examined and no less than three hundred beds analyzed. A stimulus has thus been given to use them, which will prove of incalculable value in materially improving the soil.

7. On account of the proper control and regulation of the sale of fertilizers, the acreage in cotton has been largely increased, and the western limit of the cotton belt is now fifty miles farther westward than formerly. Tobacco has likewise increased in acreage. Now where soils are worth for tobacco growing $25.00 an acre, then were worth less than $5.00.

8. Frauds in the adulteration of fertilizers have been discovered and stopped. In 1881 adulterated nitrate of soda containing 75 per cent. common salt was detected. In 1882, hair, leather and horn were found mixed with ammoniated fertilizers. In 1883 adulterated kainite and Peruvian guano were exposed. In these and other instances were the farmers protected from various frauds and swindles.

9. As a further check upon the trade, and in order to educate our farmers on this subject, the Experiment Station makes analyses of samples of fertilizers, chemicals, composts, &c., for actual North Carolina farmers, free of charge, provided the samples are taken and forwarded according to our directions.

10. The Station has stimulated home growth of industries in such a way that while in 1878 there was only one fertili-

zer factory in the State, now there are nine. Cotton Seed Oil Mills have increased in number from none in 1878 to nine at present. Many waste products have been utilized in the manufacture of waste products for making standard fertilizers—for example, tobacco stems, cotton seed meal, refuse from fish factories, &c.

11. When the coal exploration was made by the Department of Agriculture in the Deep River and Dan River sections, the Station analyzed for this survey all the samples of coal obtained, and thus largely aided in the work.

12. Hundreds of mineral waters have been examined, and large numbers of ores identified and assayed.

13. Seeds have been tested as to their purity and germinating qualities, and many adulterations detected.

14. Investigations have been made in the growth of the sugar beet, and hundreds of analyses made from samples sent from every portion of the State.

15. The Station has made all analyses for the State Board of Health, such analyses embracing many hundreds of potable waters, articles of food supposed to be adulterated, and similar others.

16. An exploration of the pyrite deposits has been made, and every bed of importance investigated and samples of each analyzed. These deposits will, at some future time, be used for the production of sulphuric acid and largely used in the manufacture of acid phosphates. For this purpose native sulphur is now used, every pound of which is brought from Europe, 4,000 miles away.

17. The officers of the Station have aided largely in the displays of the resources of the State in Boston in 1883, at our own Exposition in 1884, and in New Orleans in 1885. These exhibits have done incalculable good in advertising North Carolina and her material resources.

18. The Station has always in the past and is to-day cheerfully and promptly attending to every request by mail and otherwise, in advising as to the proper treatment for

certain soils, in giving variety of formulas for composts suitable for each individual need, and in fact answering all questions relating to scientific agriculture.

19. The officers of the Station have attended many Farmers Institutes and made addresses relative to topics of importance to the farmers, and thus, by personal contact with the people, have been instrumental in spreading information collected for their benefit.

EXPERIMENT FARM.

Not till the Spring of 1886 were the Board of Agriculture able to establish a farm in conjunction with the work of the Station and to carry out the provisions of the second part of the Act, viz: to "carry on experiments on the nutrition and growth of plants, with a view to ascertain what fertilizers are best suited to the various crops of this State, and whether other crops may not be advantageously grown on its soils." True experimental work consists of actual field trials to be supplemented by the results obtained in the laboratory. One is necessary to the other as a man's right hand is to his left. Experimental work in the field should be combined with experimental work in the laboratory. United they prove of the greatest benefit in advancing the general cause for which they should be undertaken; divided they are shorn of many of the advantages that would inevitably follow their union.

The work at the farm for many months after its establishment was preparatory in its nature. A commencement has been made, however, and with the proper facilities the work can be made of the greatest benefit to our farmers. In its workings they should take the liveliest interest, because for them it was established, and for their benefit the work is carried on.

Experiments have been already concluded, or are now in progress, with pasture and hay grasses to test the application of different fertilizers; with the different varieties of

cotton to note the relative yield of each; with the fertilization of poor land by the growth of peas and the subsequent treatment; with the cotton plant to note the growth of the roots; on the temperature of the soil at various depths; on the growth of various forage plants; on the growth and appearance of numerous pasture and hay grasses of economic importance; on the effect of different cultivation in the growth and yield of cotton; on the chemical constituents of plants in the various stages of their growth. The results of these and other experiments are recorded in the annual report for 1886 and subsequent bulletins.

RECORD OF WORK DURING 1887.

Owing to a reduction of force, brought about by decreased funds, the work accomplished during the year was necessarily not as extensive as usual.

The *Experimental Farm Work*, an outline of which has been given, was continued, and will again be referred to more in detail under appropriate headings in another part of this report.

The *State Weather Service* has continued to grow in the increased number of observing and signal stations, and the consequent usefulness to the people at large. The central station, located at the farm, was removed to quarters in the Agricultural Building so as to be more centrally located. The work of a full station was added to it at that time, and now tri-daily telegrams are sent to Washington of the state of the weather at this point. A full supply of instruments for the various records needed by a first-class signal station are in use and on exhibit for the benefit of visitors. Monthly summaries are compiled from the reports of the various signal and observing stations which are published in the monthly Bulletin of the Department of Agriculture. In its work the State Weather Service co-operates with the U. S. Signal Service, and is indebted to it for its maintenance and consequent existence. Through the latter service we are able to have distributed to numerous signal stations throughout the State the daily weather indications, cold wave and frost warnings, and special telegrams telling of possible floods and storms. In return we send to the Signal Service the result of observations taken at the various observing stations established through the State service. A more detailed account of the operations for the year in this branch of the Experiment Station will be given later on in the body of the Report.

The Laboratory Work has gone on uninterruptedly during the past year and has taken the usual range, with the exception of some farm products analyzed for the Experiment Farm. The analyses of commercial fertilizers, of marls, phosphates, composts and materials used in making them, has occupied the larger part of the time of the Station's analytical force. The number of brands of fertilizers licensed to be sold in the State during 1886 was 77.

Of these fertilizers we made 166 analyses on official and farmers' samples. These fertilizers were entered as having been manufactured in the following States: Massachusetts 4, Connecticut 2, New York 1, New Jersey 2, Delaware 4, Maryland 29, Virginia 14, North Carolina 11, South Carolina 10—total 77.

It is gratifying to note that North Carolina has now made a beginning in the competition with other States in the business of manufacturing her own fertilizers.

The following list shows the details of general analytical work during the year:

Articles Analyzed.	1887.
Fertilizers	166
Composts	6
Marls, limestones and shells	36
Minerals and ores	30
Soils	5
Cotton seed products	11
Hays and forage plants	17
Butters	3
Mineral waters	19
Health waters	23
Raw phosphates	7
Bone meal and dissolved bone	6
Home made composts	6
Thomas' phosphate	1
Cream of tartar	1
Alum earth	1
Tankage	3
Mineral deposits	3
Ensilage	1
Mucks	3
Fish scrap	3
Miscellaneous	5
	356

Publications.—The Bulletin of the Department of Agriculture has been published regularly every month during the past year, and the Experiment Station has published therein regular reports of progress, analyses of fertilizers, etc.

The editions of the Bulletin have gradually increased from 15,000 to 20,000 copies per month. It is sent free of cost to North Carolina farmers, who send their names and addresses.

Of the Report for 1886, 4,000 copies were published, and nearly all of them have been distributed. The Reports of the Station are mailed free to all who request them, whether living in the State or not.

LAWS

ESTABLISHING THE STATION AND CONTROLLING THE TRADE IN FERTILIZERS.

The following extracts from The Code of North Carolina, adopted in 1883, contain the sections pertaining to this subject, as modified by subsequent General Assemblies, which are now in force. These extracts embody all the existing laws of the State of North Carolina now (1888) in relation to the Fertilizer Control as exercised by the Experiment Station:

Sec. 2190. Tax on fertilizers; seizure, &c., of fertilizers offered for sale without license. 1876-'77, ch. 274, sec. 8; 1876-'77, ch. 291; 1881, ch. 188.

No manipulated guanos, superphosphate or other commercial fertilizer shall be sold, or offered for sale in this State, until the manufacturer or person importing the same shall first obtain a license therefor from the Treasurer of the State, for which shall be paid a privilege tax of five hundred dollars per annum, for each separate brand or quality. Any person, corporation or company, who shall violate this chapter, or who shall sell or offer for sale any such fertilizer contrary to the provisions above set forth, shall be guilty of a misdemeanor. And all fertilizers sold, or offered for sale, shall be subject to seizure and condemnation in the same manner as is provided in this chapter for the seizure and condemnation of spurious fertilizers, subject, however, to the discretion of the Board of Agriculture to release the fertilizers so seized and condemned, upon the payment of the license tax, and all costs and expenses incurred by the Department in such proceeding.

State v. *Norris*, 78—443.

Sec. 2191. Packages to be labeled; copy of label to be filed with the Commissioner at or before shipment into the State, &c. 1876-'77, ch. 274, sec. 9.

Every bag, barrel or other package of such fertilizer as above designated, offered for sale in this State, shall have thereon plainly printed a label or stamp, a copy of which shall be filed with the Commissioner of Agriculture, together with a true and faithful sample of the fertilizer which it is proposed to sell, at or before the shipment of such fertilizer into this State, and which will be uniformly used, and shall not be changed during the year for which the license is issued; and the said label or stamp shall truly set forth the name, location and trade-mark of the manufacturer; also the chemical composition of the contents of such package, and the real percentage of any of the following ingredients asserted to be present, to-wit: soluble and precipitated phosphoric acid, soluble potassa, ammonia or its equivalent in nitrogen, together with the date of its analyzation, and that the privilege tax has been paid; and any such fertilizer as shall be ascertained by analysis not to contain the ingredients and percentage set forth as above provided, shall be liable to seizure and condemnation as hereinafter prescribed, and when condemned shall be sold by the Board of Agriculture for the exclusive use and benefit of the Department of Agriculture.

Sec. 2192. Proceedings to condemn fertilizers to be by civil action, &c.; affidavit; clerk to issue order of seizure; duty of sheriff; bond of defendant; judgment. 1881, ch. 118.

The proceedings to condemn the same shall be by civil action in the Superior Court of the county where the fertilizer is on sale, and in the name of the Board of Agriculture, who shall not be required to give bond for the prosecution of said action. And at or before the summons is issued the said board shall by its agent make affidavit before the clerk of said Court of these facts:

(1.) That a license has been obtained for the sale of a fertilizer of a particular brand.

(2.) That samples of the same have been analyzed under the authority of the Board, and found to correspond with the label attached to the same.

(3.) That the defendant in the summons has in his possession, and on sale, fertilizers of the same name and brand, and bearing a label or stamp representing the analysis made.

(4.) That the fertilizers on hand and on sale are spurious and do not in fact contain the ingredients or in the proportion represented by the stamp or label on them. Whereupon the clerk shall issue his order to the sheriff of the county to seize and hold all fertilizers in the possession of the defendant labeled or stamped as the affidavit described. And the sheriff shall seize and hold the fertilizers so seized until ordered to be surrendered by the judge; unless the defendant shall give bond with justified surety, in double the value of the fertilizers seized, to answer the judgment of the court, in which case he shall surrender the fertilizers to the defendant and file this bond in the office of the clerk of the Superior Court, and thereafter the action shall be prosecuted according to the course of the court. And if it shall be established in the trial that the fertilizers seized are deficient, or inferior to the analysis represented on the stamp or brand, then the plaintiff in said action shall recover judgment on the defendant's bond for the value of the fertilizers seized.

Sec. 2193. Any merchant selling any commercial fertilizer without label or stamps attached liable to a fine of ten dollars, to be collected by the sheriff; any person offering for sale condemned fertilizers guilty of a misdemeanor. 1876-'7, ch. 274, sec. 9.

Any merchant, trader, manufacturer or agent, who shall sell or offer for sale any commercial fertilizer, without having such labels and stamps, as hereinbefore provided, attached thereto, shall be liable to a fine of ten dollars for each separate bag, barrel or package sold or offered for sale, to be sued for before any justice of the peace, and to be collected by the sheriff, by distress or otherwise, one-half, less the cost, to go

to the party suing and the remaining half to the department; and if any such fertilizer shall be condemned, as herein provided, it shall be the duty of the department to have an analysis made of the same, and cause printed tags or labels, expressing the true chemical ingredients of the same, put upon each bag, barrel or package, and shall fix the commercial value thereof at which it may be sold. And any person who shall sell or offer for sale any such fertilizer, in violation of this section, shall be guilty of a misdemeanor.

Sec. 2194. Power of the department. 1876-'7, ch. 274, sec. 10.

The Department of Agriculture shall have power and authority, at all times, to have collected samples of any commercial fertilizer offered for sale in this State, and have the same analyzed, and such samples shall be taken from at least ten per centum of the lot from which they may be selected.

Sec. 2195. Agents of railroad and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them; on failure to do so, guilty of a misdemeanor. 1876-'7, ch. 274, sec. 11.

It shall be lawful for the Department of Agriculture to require the officers, agents or managers of any railroad or steamboat company, transporting fertilizers in this State, to furnish monthly statements of the quantity of fertilizers, with the name of the consignor or consignee, delivered on their respective lines, at any and all points within this State. And said department is hereby empowered to compel said officers, agents or managers to submit their books for examination, if found expedient so to do; and any such agents, officers or managers failing or refusing to comply shall be guilty of a misdemeanor.

Sec. 2196. Establishment of an Agricultural Experiment and Fertilizer Control Station; duties of the Chemist. 1876-'7, ch. 174, sec. 12; 1879, ch. 175; 1881, ch. 373, sec. 4.

The Department of Agriculture shall establish an Agricultural Experiment and Fertilizer Control Station, and shall

employ an analyst, skilled in agricultural chemistry. It shall be the duty of the said chemist to analyze such fertilizers and products as may be required by the Department of Agriculture, and to aid as far as practicable in suppressing fraud in the sale of commercial fertilizers. He shall, also, under the direction of said department, carry on experiments on the nutrition and growth of plants, with a view to ascertain what fertilizers are best suited to the various crops of this State; and whether other crops may not be advantageously grown on its soil, and shall carry on such other investigations as the said department may direct. He shall make regular reports to the said department, of all analyses and experiments made, which shall be furnished, when deemed needful, to such newspapers as will publish the same. His salary shall be paid out of the funds of the Department of Agriculture.

Sec. 2204. Dealers in fertilizers authorized to sell surplus on hand not exceeding ten tons. 1883, ch. 291, sec. 7.

Any dealer in fertilizers who may have on hand a quantity not exceeding ten tons when the license for the year expires, shall not be prevented from selling the same without further taxes.

Sec. 2205. Manufacturers liable to no other tax than five hundred dollars. 1883, ch. 291, sec. 8.

Whenever any manufacturer of fertilizers shall have paid the license tax of five hundred dollars, his goods shall not be liable to any further tax, whether by city, town or county.

THE FERTILIZER CONTROL AND THE TRADE DURING 1887.

A chemical control of the trade in commercial fertilizers in this State is made by the law the second leading purpose of this Station. The analysis of fertilizers, which was constituted its earliest work, has during the past year continued to occupy the largest portion of our time, although it is no longer the only work.

The law on this subject is found in Sections 2190 to 2196 of The Code. It was a wise provision of the law which gave the farmer this protection at the time it did. The fertilizer trade was just being established in the State, and, while there were many excellent articles, there were many worthless ones which, through ignorance more than fraud, were offered the farmers of the State, who had no means whatever of selecting the good. This was remedied by the system of careful inspection and analysis which the Legislature of 1877 gave the State and which is still in force. The condition of the trade in fertilizers has steadily improved, year by year, since that time. If this control had not been established, it is safe to say that not one-half the fertilizer now sold would find consumption among us.

This system of fertilizer control is based upon two simple principles; first, the license of the manufacturer to sell a brand or article of a guaranteed composition and grade; second, the inspection and analysis of all fertilizers, when licensed, to see that this guarantee is sustained. The first requirement involves a formal announcement and an exact statement by the manufacturer of what he proposes to sell. No particular grade of composition is named in the law, but the Commissioner of Agriculture is authorized to admit to

competition in the trade of the State every description or grade of article which can be reasonably supposed to meet the wants of any crop or farm.

From the nature of a fertilizer its purchaser cannot judge of its character or richness, as the purchaser of sugar or salt can of the quality of those articles. The farmer must call in the help of the chemist to dissect the sample, weigh its valuable ingredients and estimate its worth. It is just this that the State has provided shall be done once for all of its agriculturists through the Experiment Station.

REGULATIONS OF THE FERTILIZER CONTROL.

By a review of the existing laws printed in this report the following requirements can easily be understood:

Manufacturers are required to take out annually a license, for which they pay $500, and file with the Commissioner of Agriculture their stamp or brand, with a true and faithful sample of the same, which the law requires shall include the guaranteed analysis of the article, and must be uniform upon all packages, and which cannot be changed during the year for which the license is taken. The license is required upon each different "brand or quality." Every such brand has then the freedom of the whole State. Experience has proved that this plan is the fairest and best for all concerned. It is simple, can be easily carried out, and causes the manufacturer, the dealer and the farmer alike the least trouble.

The following ruling of the Board of Agriculture further defines the classes of articles which are taxable:

"At a meeting of the Board of Agriculture, October 15th, 1879, it was resolved that the following articles shall be admitted free of tax, with such additions or changes as may afterwards be made by the Executive Committee, upon consultation with the chemist, viz: ground bone, bone ash, ground bone black, ground phosphate rock, or other mineral phosphate, nitrogenous organic matter commercially free from phosphoric acid and potash, nitrate of soda, nitrate of potash (saltpetre), sulphate of ammonia, muriate of ammonia, kainite, sulphate of magnesia, sulphate of potash, sulphate of soda, muriate of potash, lime, plaster, ground cracklings, ground tankage, salt and oil of vitriol."

Upon the following articles the license tax will be exacted:

"Any of the above articles, or others, sold for fertilizing material *under any trade-mark or proprietary brand;* upon dissolved bone, dissolved bone black, dissolved mineral phosphates, (all acid phosphates or superphosphates), and upon any two or more of the articles mentioned in the first list, if combined either chemically or mechanically."

To make plain the requirements of the law in the matter and to secure uniformity, the following scheme is recommended for the brand:

(Weight of bag) .....
(Name of brand) .....
(Trade-mark) .....
(Manufacturer's address) .....
Analysis .....(date).....
Available phosphoric acid .....per cent.
Nitrogen (or ammonia, if claimed,) ..... "
Potash (if claimed) ..... "
North Carolina privilege tax paid.

The phosphoric acid should not be expressed as bone phosphate alone. By available phosphoric acid is meant the sum of the soluble and the so-called "reverted."

The methods of the Association of Official Agricultural Chemists are used. Total nitrogen will be determined and credit given for all available forms. Owing to the difficulty in discriminating between the different sources whence nitrogen is obtained in compound superphosphates, it is not attempted to give a different valuation to each different nitrogenous material in these articles. But leather scrap, horn scrap, wool-waste and similar materials are considered as fraudulently present in such goods, unless special mention is made on the bags. Special steps will always be taken to detect their presence, and when found in any sufficient amount to affect the value of the goods, mention will be made of the fact. Nitrogen may be expressed as such or as ammonia. The potash referred to is that soluble in water. It should be expressed simply as potash (K_2O). The per centages may be given within reasonable limits. These

limits should not be greater than two per cent. on the available phosphoric acid, ½ per cent. on the nitrogen, and ½ per cent. on the potash. In no cases can these limits be exceeded.

Samples of fertilizers are drawn under the supervision and immediate direction of the Commissioner of Agriculture. Great care is taken to get the fairest possible sample of the brand offered for sale. Every possible precaution, fairly within the powers of an inspector, is taken to attain this end. The analyses of official samples are published.

The Agricultural Experiment Station receives the samples with a number only. The name of the brand is not known until the report of the analysis is put on file in the Commissioner's office. When this has been done, the actual returns of the analysis are compared with the composition guaranteed or branded on the bag. The manufacturer then receives a copy of the analysis. If the article is shown by the analysis to be deficient at any point, the manufacturer or agent has an opportunity to correct the mistake. The matter having been fully decided, the analysis is published in the papers of the State. In all cases where the law is not satisfied promptly its penalties are exacted.

Our certified and sealed duplicates of official analyses of fertilizers licensed in this State will be furnished gratis to the manufacturers and their agents.

The fertilizer control, as organized in the State, has supplied just what is needed for the protection of the farmer in the intelligent use of fertilizers, without giving rise to any artificial or unnecessary restrictions on trade. It is believed that the law of this State is superior to every other fertilizer law in these respects. It creates no artificial or arbitrary limits to the composition of fertilizers. It insures perfectly good faith between manufacturer, agent and consumer. It is simple and requires a minimum of machinery, of expenditure and of espionage, a thing distinctively disagreeable to all American citizens. Its history will show that its execution involves the fewest difficulties or embarrassments for all concerned.

FARMERS' FERTILIZER ANALYSES.

As a further check upon the trade, and in order to educate our farmers on this subject, the Experiment Station will make analyses of samples of fertilizers, chemicals, composts, &c., for actual North Carolina farmers, free of charge, provided the samples are taken and forwarded according to our directions, as follows:

N. C. Experiment Station.

DIRECTIONS FOR SAMPLING FERTILIZERS.

The Station makes analyses for North Carolina farmers, without charge, provided the samples are taken according to these directions, and the proper form is completely filled up and certified to.

Samples when accepted will be entered upon our register in the order of their coming, and analyzed in turn.

The results of each analysis will be promptly communicated to the person sending the sample.

Fertilizers are sampled by the regular inspector, for official analysis and publication.

The valuation of a high-priced fertilizer requires the amounts or per cent. of its principal fertilizing elements to be known. Chemical analysis of a small sample, so taken as to fairly represent a large lot, will show the composition of the lot.

The subjoined directions, if faithfully followed, will insure a fair sample. Especial care should be observed that the sample neither gains nor loses moisture during the sampling or sending, as may easily happen in the extremes of weather, or even from a short exposure to sun and wind, or from keeping in a poorly-closed vessel.

1. Provide a tea cup, some large papers, and for each sample a glass fruit jar, or tin can or box, holding about one quart, that can be tightly closed—all to be clean and dry.

2. Weigh separately at least three (3) average packages (barrels or bags) of the fertilizer, and enter these actual weights in the "form for sending fertilizer samples."

3. Open the packages that have been weighed, and mix well together the contents of each, down to one-half its depth, emptying out upon a clean floor, if necessary, and crushing any soft, moist lumps, in order to facilitate mixture, but leaving hard, dry lumps unbroken, so that the sample shall exhibit the texture and mechanical condition of the fertilizer.

4. Take out five equal cupfuls from different parts of the mixed portions of each package. Pour them (fifteen in all) one over another, upon a paper, intermix again thoroughly but quickly; to avoid loss or gain of moisture, fill a can or jar from this mixture, close tightly, label plainly, and send, charges prepaid, to the

"N. C. Agricultural Experiment Station,
Raleigh, N. C."

The following form should be filled up and sent at the same time by mail: (Blanks supplied on application).

N. C. Experiment Station.

FORM FOR SENDING FERTILIZER SAMPLES.

This form must be filled up completely.

Never send a sample given you by a manufacturer or dealer.

Station No. ....

Date of taking samples, ... 188..

The North Carolina Agricultural Experiment Station, Raleigh, N. C.:

Sir:—I send you to-day, marked ..... contained in a ....., a fair sample, drawn according to directions, of the following fertilizer:

Weight branded on each bag or package ..... pounds. Actual weight of one bag or package ..... pounds.

Name of fertilizer .....

Manufactured by ....., at .....

Purchased of, or received from ....., at .....

Selling price per ton, or hundred, bag or barrel, $.....

Give the amounts of the following ingredients as branded on the bags:

Available (or soluble and reverted phosphoric acid) .....

Nitrogen (or ammonia), if claimed .....

Potash, if claimed .....

I hereby certify that the above is a correct statement.

Name .....

Post-office .....

FERTILIZERS DURING 1887.

Under this control the trade in fertilizers has continued in a healthy state during the past two years. The following table shows the number and description of fertilizers licensed to be sold in North Carolina during the years 1881 to 1887, inclusive:

	1881.	1882.	1883.	1884.	1885.	1886.	1887.
"Acid phosphates," or simple superphosphates	8	10	11	7	9	11	10
Superphosphates with potash	9	15	15	10	10	9	8
Ammoniated superphosphates	40	55	61	59	63	66	58
Natural guanos	1	3	2	3	2	3	1
Agricultural lime	1	1	2	1	1	1	--
Specialties	--	2	1	--	--	--	--
	59	86	92	80	85	90	77

Where did these fertilizers come from? In compiling the next table, we have ascertained, as far as possible, where each brand sold in the State in each of the years from 1880 to 1887, inclusive, was manufactured, and have credited it to that State.

WHERE THE FERTILIZERS ARE MANUFACTURED.

	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
Massachusetts	2	3	--	2	2	3	1	4
Connecticut	1	2	2	4	3	3	1	2
New York	3	6	5	3	2	4	3	1
New Jersey	3	3	1	1	1	2	3	2
Delaware	2	2	2	2	2	4	4	4
Maryland	21	25	45	42	30	31	35	29
Pennsylvania	--	--	1	1	--	--	1	--
Virginia	7	9	15	17	20	18	21	14
North Carolina	3	3	6	6	8	9	10	11
South Carolina	5	6	9	14	12	11	11	10
Totals	47	59	86	92	80	85	90	77

It is gratifying to note that North Carolina is beginning

to compete in the business of manufacturing her own manures.

The average composition of the ammoniated superphosphates with potash (so-called complete fertilizers), for each year, was as follows:

AMMONIATED SUPERPHOSPHATES, WITH POTASH.

	Average in						
	1880.	1882.	1883.	1884.	1885.	1886.	1887.
Available phosphoric acid	7.40	8.91	8.59	8.15	9.13	8.69	8.54
Ammonia	2.70	2.60	2.33	2.67	2.65	2.53	2.43
Potash	1.30	1.82	2.18	2.13	2.34	2.30	2.08
Valuation on the 1887 basis	$19.56	$21.72	$20.80	$21.27	$22.69	$21.69	20.96

In calculating the valuations, the same figures have been applied to the average analysis of each year, for the purpose of comparing them. These figures prove that there has been marked improvement in the quality of this kind of fertilizer from 1880 to 1887. By the same analyses the average per cent. of available phosphoric acid has increased from 7.40 in 1880 to 9.13 in 1885, and 8.54 in 1887; the average per cent. of potash has increased from 1.30 in 1880 to 2.08 in 1887, while the per cent. of ammonia remains remarkably near one figure for all the years except 1883, when ammoniates were unusually scarce. Thus the valuation of the average fertilizer, using the prices of 1887 for all analyses alike, has, with a few fluctuations, steadily climbed up from $19.56 per ton, in 1880, to $21.69 per ton, in 1886, and $20.96 in 1887. It is a notable fact that during this period, 1880 to 1887, the actual cash prices paid by North Carolina farmers for these fertilizers has largely decreased, while the quality or grade has much improved. This means that North Carolina farmers could get in 1887 a greatly superior article to that of 1880, and at a greatly reduced price.

The *relative* valuations merely furnish a convenient method of summing up the results of the analyses and of comparing them. They are not intended, of course, to fix the price at which the articles ought to be sold all over the State. Difference in freights to different points renders this impossible. Neither do they represent the *agricultural* value of the articles. This is a very different thing indeed from the commercial or market value of an article. The actual agricultural value of a manure, applied to a particular soil or crop, depends upon a great number of conditions, the properties of the soil, the cultivation, variations in the weather, &c., as well as the properties of the manure. The agricultural value and the commercial value have no fixed relation in fact; although in using fertilizers we always hope and expect that the value to us in the field will exceed their cost enough to give us a profit.

A conference of the State chemists of Virginia, North Carolina, South Carolina, Georgia and Alabama, in September, 1885, agreed upon a new plan for estimating these values, which will be uniform for all these States.

The values we give in connection with the analyses of fertilizers in 1887 represent the *relative commercial cash values on our seaboard*, that is, at Wilmington, Beaufort, Newbern, Washington, Edenton or Elizabeth City. They apply as well to points like Portsmouth (Norfolk) and West Point. To ascertain the cash value for interior points it will be necessary to add the freight from the port of entry to that point. In case of fertilizers manufactured in the interior of the State, it will be necessary to add to the value which we report, the amount of freight for one ton from Wilmington, Portsmouth or the usual port for that place. For example, to ascertain the commercial cash value of a ton of fertilizer at Raleigh, add to our value at the seaboard the amount of freight for one ton from Wilmington or Portsmouth, as the

case may be. At Charlotte, add to the reported value the freight from Charleston, Wilmington or West Point, and so for every other point.

This plan differs materially from the plan previously pursued, and we ask especial attention to this. The plan followed by the Station in 1885, and all previous years, in common with most of the bureaus of the same kind, was to ascertain the average cash value of fertilizers at the chief *interior* centres of the trade, such as Raleigh and Charlotte, and to base the estimates upon this. This plan, always very unsatisfactory, became entirely impracticable when the competition of different fertilizer-manufacturing centres cut down the prices to the lowest margin of profits. The figures agreed upon for use during 1887 were:

AT THE SEABOARD:

"Available" phosphoric acid	6½ cents per pound.
Ammonia	16 " " "
Potash	5 " " "

To illustrate the significance and application of this plan and figures: suppose an acid phosphate on sale at Wilmington contains 12½ per cent. of soluble and reverted phosphoric acid (which together are called "available"). 12½ pounds in 100 is 250 pounds in a ton. Multiply 250 by 6½ cents, the figure for one pound "available," and you get $16.25 as the cash value of the article at retail. Now, this signifies that the man who pays cash can get that article at Wilmington at that price, the way the market stands at present. Or, supposing the freight to Charlotte is $2.50, the man who pays cash in Charlotte can get that article at $18.50, which is the Wilmington cash value with freight added.

This must not be understood as applicable to any but cash purchasers.

On the one hand, the man who buys largely, or offers other inducements, will get his fertilizer cheaper. On the

other, the farmer who promises to pay in a fluctuating staple next November must expect to pay considerable money in addition for the time and risk.

The Station made 166 analyses of samples of commercial fertilizers during 1887. Some of these were farmers' samples. This is nearly 2½ analyses of each brand sold in the State that year. This does not include the analyses of phosphates, agricultural chemicals, or other ingredients of fertilizers.

The analyses in the following tables were all made on samples drawn according to law by the special agents of the Department of Agriculture from new lots of goods received in the State after the beginning of the new year. On the even pages will be found a list of fertilizers licensed to be sold in the State during the year, with the addresses of the manufacturers or general agents. On the page opposite the name is the analysis and relative valuation of the fertilizer.

In many instances several analyses are given for one brand. In most cases the analyses agree fairly well, and thus reflect credit upon their makers. In other cases, resulting probably from carelessness in mixing, or some mistake in bagging or shipping, the samples differed somewhat in character, and as it was impossible to ascertain which one of them correctly represented the true character of the goods of this name on sale in the State, the varying analyses are all published.

The water given is that lost by continued heating at the temperature of boiling water. The insoluble phosphoric acid is that contained in phosphates which fail to dissolve in neutral ammonium citrate solution (sp. gr. 1.09) by the method of the Association Official Agricultural Chemists.

The soluble phosphoric acid is that free or in form of phosphates (generally the one-lime phosphate or acid phosphate of lime), soluble in pure cold water. The "reverted" is that insoluble in water, but dissolving in neutral standard ammonium citrate solution. This is all that the term *reverted* signifies here, and it is used simply to stand for the

phrase, "insoluble in pure water, but soluble in standard ammonium citrate solution under the standard conditions." It is generally agreed that it is within the power of plants to take up directly the phosphates so dissolving, or in other words, that these phosphates are "available."

The total "available phosphoric" acid is simply the sum of the soluble and "reverted." The nitrogen is given as such, and calculated to its equivalent, ammonia. The potash is given as simple, uncombined potash (K_2O).

The number of the analysis on the Station books is given in the first column at the left, and the place where this particular sample was drawn, in the column at the right of the first page. In the tables the first set of figures of each brand represent the spring analyses, the second set, marked "F," indicates the fall analyses of samples of the same brands.

Station No.	NAME.	ADDRESS OF MANUFACTURER OR GENERAL AGENT.	SAMPLED AT	
4276	Acid Phosphate	Rasin Fertilizer Co., P.O.Box 715, Baltimore, Md.,	Raleigh	1
4298	Acme Fertilizer	Acme Manufacturing Co., Wilmington,	Selma	2
4329	Allison & Addison Acid Phosphate,	Allison & Addison, Richmond, Va,	Greensboro	3
----	Ammoniated Bone	Maryland Fertilizer and Manufacturing Co., Baltimore,	----------	4.
4270) F 4559)	Ammoniated Dissolved Bone,	John Merrymon & Co.,24 Second street, Baltimore, Md.,	Lumberton Shelby	5
4300) F 4530)	Ammoniated Soluble Navassa Guano,	Navassa Guano Co., Wilmington, N. C.,	Raleigh Siler	6
4338	Anchor Brand for Tobacco,	Southern Fertilizing Co., 1321 Cary street, Richmond, Va.	Hillsboro	7
4263) F 4571)	Ashepoo Acid Phosphate	Ashepoo Phosphate Co., Robertson, Taylor & Co., Ag'ts, Charleston, S. C.,	Charlotte Charlotte	8
F 4570	Ashepoo Fertilizer	Ashepoo Phosphate Co., Robertson, Taylor & Co., Ag'ts, Charleston, S. C.,	Charlotte	9
4310) F 4565)	Atlantic Acid Phosphate,	Atlantic Phosphate Co., Charleston, S. C.,	Raleigh Shelby	10
4314	Baker's Standard Guano,	Chemical Co. of Canton, 32 & 34 S. Charles st., Baltimore,	Clayton	11
4313	Baltimore Soluble Bone,	Baltimore Guano Co., 32 & 34 S. Charles st., Baltimore,	Raleigh	12
4370	Bone and Potash Compound,	Baugh & Sons, Baltimore, Md.,	Franklinton	13
----	"Bos" Ammoniated Superphosphate,	Wm. Davison & Co., Box 227, Baltimore, Md.,	----------	14
4269	Bradley's Patent Superphosphate of Lime,	Bradley Fertilizing Co., Lewis F. Detrick, Gen. Ag't, 108 S. Charles st., Baltimore, Md.,	Wilmington	15
4386	British Mixture	E. B. Whitman, 104 S. Charles st., Baltimore, Md.,	Greensboro	16

	Water.	Insoluble phos. acid.	Soluble phos. acid.	Reverted phos. acid.	TOTAL AVAILABLE PHOSPHORIC ACID.		Nitrogen.	EQUIVALENT TO AMMONIA.		POTASH.		Relative com. value per ton at the Seaboard.
					Fou'd	Guarant'd.		Fou'd	Guarant'd.	Fou'd	Guarant'd.	
1	17.16	2.79	5.56	5.79	11.35	13 to 14	....	....	.....	....	.....	$ 14.76
2	12.98	0.93	5.95	2.05	8.00	8	2.28	2.77	3	2.54	2½	21.80
3	13.69	2.28	7.50	2.32	9.82	9 to 11	....	....	.....	3.18	1¼ to 1½	15.95
4	....	....	...	....	....	.....	....	....	.....	....	.....	.....
5	11.41	3.19	7.05	1.91	8.96	8	1.90	2.31	2	1.67	1	20.71
	11.81	2.44	7.60	1.84	9.44		1.85	2.25		1.88		21.35
6	13.98	3.72	3.47	5.28	8.75	9	2.53	3.07	2¼	1.72	1¼	22.92
	19.53	4.39	4.20	3.90	8.10		2.57	3.12		1.91		22.42
7	10.81	4.50	5.90	1.86	7.76	8½ to 10	3.08	3.74	3 to 3½	1.38	2 to 3	23.44
8	16.26	0.60	10.62	2.49	13.11	10.00	....	....	.....	1.68	1	18.92
	16.37	2.16	8.61	3.08	11.69					1.73		16.93
9	16.73	2.00	8.33	1.21	9.56	8	1.82	2.21	2	2.07	1	21.57
10	15.45	1.29	8.62	2.12	10.74	10	....	....	.....	1.43	1	15.39
	13.79	1.79	8.61	2.15	10.79					1.28		15.31
11	16.43	3.26	6.45	1.50	7.95	8 to 11	1.84	2.23	2 to 3	2.63	2 to 3	20.11
12	18.84	0.10	10.54	1.39	11.93	12 to 14	....	....	.....	....	.....	15.51
13	11.79	3.54	4.03	3.07	7.10	6 to 8	1.78	2.16	2 to 2½	2.31	2 to 3	18.45
14	....	....	....	....	....	.....	....	....	.....	....	.....	.....
15	16.14	2.41	8.55	1.39	9.94	9.45	2.10	2.55	2.40	1.84	1	22.92
16	12.39	3.95	6.29	1.31	7.60	8 to 10	2.05	2.49	2 to 3	2.62	2 to 3	20.47

Station No.	NAME.	ADDRESS OF MANUFACTURER OR GENERAL AGENT.	SAMPLED AT	
4356 4427	Chesapeake Guano	Chesapeake Guano Co., 21 P. O. Avenue, Baltimore, Md.,	Raleigh Raleigh	17
4290 F 4558	Diamond Soluble Bone	Walton, Whann & Co., Wilmington, Del.,	New Berne Shelby	18
4292	Diamond State Superphosphate,	Lord & Polk, Odessa, Del.,	Middleburg	19
4332 F 4531	Dissolv'd Bone Phosphate of Lime, Pacific,	John S. Reese & Co., 10 South street, Baltimore, Md.,	Pineville Siler	20
4337 F 4553	Durham Ammoniated Superphosphate,	Durham Fertilizer Co., Durham, N. C.,	Durham Salisbury	21
4288	Eddystone Soluble Guano	Clark's Cove Guano Co., New Bedford, Mass., John M. Green, Manag'r, Atlanta, Ga	Youngsville	22
F 4572	Edisto Dissolved Bone	Edisto Phosphate Company, Charleston, S. C.,	Statesville	23
4354	Empire Guano	Rasin Fertilizer Co., P. O. Box 715, Baltimore, Md.,	Cary	24
4265 4241 4311 F 4564	Etiwan Dissolved Bone	Etiwan Phosphate Co., Charleston, S. C.,	Wadesboro New Berne Raleigh Shelby	25
4243 4385	Farmers' Bone Fertilizer	Enterprise Fertilizing Co., Tarboro,	Tarboro Tarboro	26
4294 4341 F 4529	Farmers' Friend Fertilizer,	Read & Co., 88 Wall street, N. Y.,	Franklint'n Greensboro Siler	27
.....	Fish Hawk Guano	Freeman, Lloyd, Mason & Dryden, Norfolk, Va.,	.....	28
4334	Game Guano	Baltimore Guano Co., 32 S. Charles st., Baltimore, Md	Hillsboro	29
4346	Gem Fertilizer	Acme M'f'g Co., Wilmington, N. C.,	Fair Bluff	30
4267	Gibbs & Co.'s High Grade Ammoniated Phosphate	E. J. Powers, Wilmington, N. C.,	Lumberton	31
.....	Good Luck Guano	The R. J. Ruth & Co., 6 S. street, Baltimore, Md.,	.....	32

	Water.	Insoluble phos. acid.	Soluble phos. acid.	Reverted phos. acid.	TOTAL AVAILABLE PHOSPHORIC ACID.		Nitrogen.	EQUIVALENT TO AMMONIA.		POTASH.		Relative com. value per ton at the Seaboard.
					Fou'd	Guarant'd.		Fou'd	Guarant'd.	Fou'd	Guarant'd.	
17	14.55	4.02	4.09	3.80	7.89	8 to 10	1.80	2.19	2 to 2½	1.76	1½ to 2	$ 19.03
	14.38	4.04	4.23	3.54	7.77		1.72	2.09		1.73		18.52
18	14.85	2.99	9.75	2.09	11.84	12 to 15	....	....	.....	....	.....	15.39
	12.47	2.93	9.85	2.32	12.17							15.82
19	14.65	1.92	6.79	1.64	8.43	8½ to 10½	2.45	2.97	2½ to 3½	3.62	3 to 4	24.08
20	13.28	5.51	8.72	2.38	11.10	10 to 12	....	....	.....	....	.....	14.43
	16.08	2.88	7.42	4.86	12.28							15.96
21	9.63	2.46	4.64	3.11	7.75	8 to 10	2.08	2.53	2½ to 3	1.80	2 to 2½	19.98
	9.56	2.23	5.33	2.48	7.81		1.96	2.38		1.55		19.32
22	16.61	4.04	4.70	2.84	7.54	8 to 10	1.51	1.83	2 to 2½	1.48	1 to 1½	17.14
23	18.78	0.46	11.51	2.40	13.91	12 to 15	....	....	.....	....	.....	18.08
24	15.11	2.76	3.48	4.39	7.87	8 to 10	2.21	2.68	2 to 2¼	1.65	1½ to 1¾	20.46
25	14.36	2.51	10.71	1.98	12.69	13 to 15	....	....	.....	....	.....	16.50
	16.24	2.25	9.83	2.29	12.12							15.76
	13.53	2.61	9.91	2.49	12.40							16.12
	14.19	3.22	9.67	2.50	12.17							15.82
26	14.34	1.59	7.33	1.95	9.28	8 to 11	1.56	1.89	2½ to 3	2.35	2 to 2½	20.46
	12.88	1.59	4.27	3.36	7.63		1.76	2.14		2.60		19.37
27	15.68	2.01	6.95	1.45	8.40	9 to 11	1.82	2.21	2¼ to 3¼	1.13	1 to 2	19.12
	15.20	0.82	7.48	2.16	9.64		2.35	2.85		2.29		23.94
	15.65	1.42	6.69	2.37	9.06		2.08	2.53		1.89		21.77
28	....	....	....	....	....	.....	....	....	.....	....	.....	.....
29	14.89	3.99	4.91	2.75	7.66	9 to 11	2.11	2.56	2 to 3	2.72	2 to 3	20.87
30	11.83	1.07	5.76	2.39	8.15	8	1.66	2.02	2	2.81	2	19.87
31	13.71	2.32	6.86	2.42	9.28	8 to 10	2.21	2.68	2 to 3	1.84	1 to 2	22.48
32	....	....	....	....	....	.....	....	....	.....	....	.....	.....

Station No.	NAME.	ADDRESS OF MANUFACTURER OR GENERAL AGENT.	SAMPLED AT	
4244 F 4555	Harvest Queen Phosphate,	Lister's Agricult'al Chemical Works, Newark, N. J.,	New Berne Shelby	33
4355	High Grade Premium Guano,	George L. Arps, Norfolk, Va.	Cary	34
4330 F 4566	L. & R. Acid Phosphate	Lorentz & Rittler, 70 South st., Baltimore, Md.,	Salisbury Concord	35
4353 4426	L. & R. Ammoniated Guano,	Lorentz & Rittler, 70 South st., Baltimore, Md.,	Jonesboro Raleigh	36
4307 4361	Lazaretto Acid Phosphate,	Lazaretto Chemical and Fert. Works, G. W. Grafflin, Prop., 14 S. Holiday st., Baltimore,	Raleigh Raleigh	37
4350 F 4581	Lister's Ammoniated Dissolved Bone Phosphate	Lister's Agricultu'l Chemical Works, Newark, N. J.,	Cameron Concord	38
4301	Long's Prepared Chemicals,	Long & Dugdale, 37 S. Gay st., Baltimore, Md.,	Raleigh	39
------	Meadow's Special Guano for all crops,	E. H. & J. A. Meadows, New Berne, N. C.,	------	40
4348	Miles IXL. Ammoniated Bone Superphosphate	John Guyer, Milford, Conn.	Cameron	41
4303 4452 4371 4406 F 4552	National Fertilizer	S. W. Travers & Co., Richmond,	Selma Statesville Wake For'st Statesville Salisbury	42
4268 F 4534	Navassa Acid Phosphate	Navassa Guano Co., Wilmington,	McFarlan Siler	43
------	Orchilla Guano	S. W. Travers & Co., Richmo'd	------	44
4342 4399	Oriole Fertilizer	Symington Bros. & Co., Baltimore, Md.,	Greensboro Raleigh	45
4282	Owl Brand Guano	Davie & Whittle, Petersburg, Va.,	Wake For'st	46
------	Owl Brand Tobacco Guano,	Davie & Whittle, Petersburg, Va.,	------	47
4289 4372	Patapsco Guano	Patapsco Guano Co., 14 South Holiday st., Baltimore, Md.	Louisburg Franklint'n	48

	Water.	Insoluble phos. acid.	Soluble phos. acid.	Reverted phos. acid.	TOTAL AVAILABLE PHOSPHORIC ACID.		Nitrogen.	EQUIVALENT TO AMMONIA.		POTASH.		Relative commercial value per ton at the Seaboard.
					Fou'd	Guarant'd.		Fou'd	Guarant'd.	Fou'd	Guarant'd.	
33	13.88	2.11	7.36	1.37	8.73	10 to 12	1.25	1.52	1 to 2	3.53	1½ to 2	$ 19.74
	12.16	2.56	7.39	2.46	9.85		1.35	1.64		1.83		19.90
34	15.38	1.55	7.59	0.89	8.48	8	1.83	2.22	2	2.24	1	20.36
35	15.26	1.11	3.70	6.84	10.54	10 to 12	....	....	.....	2.20	2 to 2½	15.90
	12.97	3.49	8.56	1.01	9.57					3.37		15.81
36	13.53	3.68	6.41	1.03	7.44	8 to 10	1.44	1.75	2 to 2½	2.59	1½ to 2	17.86
	13.45	3.81	6.55	1.05	7.60		1.49	1.81		2.61		18.38
37	13.40	2.38	8.88	3.06	11.94	14.13	....	....	.....	....	.....	15.52
	12.83	2.56	9.11	2.48	11.59							15.07
38	13.67	1.68	8.28	0.89	9.17	8 to 10	2.08	2.53	2 to 2½	1.91	1½ to 2	21.93
	12.83	1.38	8.89	1.15	10.04		1.95	2.37		1.73		22.37
39	11.53	4.70	7.52	2.84	10.36	12	....	....	.....	1.68	1.80	15.15
40	....	....	....	....	....	.....	....	....	.....	....	.....	.....
41	17.13	1.83	4.90	3.79	8.69	8 to 10	1.54	1.87	2¼ to 2¾	1.69	1 to 1¼	18.97
42	13.33	0.90	7.01	1.36	8.37	8 to 10	1.74	2.11	2 to 2½	2.54	2 to 2¾	20.17
	11.40	1.96	4.45	3.42	7.97		1.74	2.11		2.82		19.93
	13.33	1.16	6.46	1.62	8.18		2.40	2.91		2.53		22.47
	10.25	1.34	6.35	1.85	8.20		1.74	2.11		2.39		19.80
	9.21	4.66	2.60	4.65	7.25		2.30	2.79		2.65		21.00
43	15.91	2.72	8.24	2.17	10.41	10.50	....	....	.....	1.23	1¼	14.76
	16.15	2.10	8.39	2.38	10.77					1.90		15.90
44	see p 49	....	....	....	....	.....	....	....	.....	....	.....	.....
45	13.95	2.79	7.42	1.14	8.56	9 to 11	1.85	2.25	2 to 3	2.37	2 to 3	20.70
	11.83	2.66	6.92	1.64	8.56	9 to 11	1.87	2.27	2 to 3	2.52	2 to 3	20.91
46	18.61	2.35	6.35	3.31	9.66	8 to 10	1.71	2.08	2 to 2½	1.26	1 to 1¾	20.47
47	....	....	....	....	....	.....	....	....	.....	....	.....	.....
48	13.13	2.72	6.41	3.19	9.60	8 to 10	1.92	2.33	2½ to 3	1.57	1½ to 2	21.51
	13.67	2.52	6.78	2.34	9.12		2.09	2.54		1.55		21.54

Station No.	NAME.	ADDRESS OF MANUFACTURER OR GENERAL AGENT.	SAMPLED AT	
4363	Peruvian Mixture	American Fertilizing Co., Norfolk, Va.,	Raleigh	49
4306 F 4568	Piedmont Special Fertilizer,	Piedmont Guano and M'fgCo. 49 South st., Baltimore, Md.,	Raleigh High Point	50
.....	Piedmont Guano for Tobacco,	Piedmont Guano and M'fgCo. 49 South st., Baltimore, Md.,	.....	51
4264 4381	Pine Island Ammoniated Phosphate,	Quinnipiac Fertilizer Co., New London, Conn.,	Wilmington Raleigh	52
4309 4275	Pocomoke Superphosphate,	Freeman, Lloyd, Mason & Dryden, Norfolk, Va.,	Raleigh Raleigh	53
4302	Prolific Cotton Grower	Goldsboro Oil Co., Goldsboro	Selma	54
4232 4336 4382	Raleigh Standard Guano	Raleigh Oil Mills and Fertilizer Co., Raleigh, N. C.,	Wake For'st Raleigh Raleigh	55
4291 F 4563	Raw Bone Superphosphate Plow Brand,	Walton, Whann & Co., Wilmington, Del.,	Louisburg Shelby	56
4266 4305 F 4556	Red Navassa Guano, Ammoniated,	Navassa Guano Co., Wilmington, N. C.,	McFarlan Raleigh Shelby	57
4299 F 4561	Reliance Ammoniated Superphosphate,	Walton, Whann & Co., Wilmington, Del.,	Selma Concord	58
4333 4383 F 4533	Royster's High Grade Acid Phosphate,	Royster & Strudwick, Norfolk, Va.,	Concord Tarboro Siler	59
4351	Sea Fowl Guano	Bradley Fertilizi'g Co., Lewis F. Detrick, Gen'l Ag't, 108 S. Charles st., Baltimore,	Cameron	60
4344 F 4566	Soluble Pacific Guano	John S. Reese & Co., General Agents Pacific Guano Co., 10 S. st., Baltimore, Md.,	Pineville Shelby	61
4349	Special Cotton Compound,	G. Ober & Sons' Co., 85 Exchange Place, Baltimore. Md	Cameron	62
4339	Special Compound for Tobacco,	G. Ober & Sons' Co., 85 Exchange Place, Baltimore. Md	Winston	63
4340 4384 F 4533	Star Brand Guano	Allison & Addison, 1322 Cary st., Richmond, Va.,	Greensboro Raleigh Burlington	64

	Water.	Insoluble phos. acid.	Soluble phos. acid.	Reverted phos. acid.	TOTAL AVAILABLE PHOSPHORIC ACID.		Nitrogen.	EQUIVALENT TO AMMONIA.		POTASH.		Relative com. value per ton at the Seaboard.
					Fou'd	Guarant'd		Fou'd	Guarant'd	Fou'd	Guarant'd	
49	13.79	2.07	6.77	1.82	8.59	7 to 9	2.20	2.67	1½ to 2½	2.32	1 to 2	$ 22.03
50	16.35	1.22	5.32	3.17	8.49	8 to 10	1.75	2.12	2 to 2½	1.67	1 to 1¼	19.49
	13.97	2.26	5.99	3.11	9.10		1.76	2.14		1.75		20.43
51	----	----	----	---	- --	--- ---	----	----	---------	----	------	------
52	15.41	2.72	7.80	2.16	9.96	8	1.94	2.35	2	1.70	1	22.17
	14.98	3.11	7.70	1.80	9.50	8	2.09	2.54	2	2.00	1	22.48
53	15.95	1.65	6.04	1.80	7.84	9 to 10	2.64	3.20	2 to 3	2.60	1½ to 2½	23.03
	15.95	2.15	6.33	1.49	7.82		2.40	2.91		2.45		21.93
54	12.20	1.52	6.81	1.65	8.46	9½ to 10½	2.22	2.70	2½ to 3	1.79	2 to 2½	21.43
55	11.46	0.88	6.65	2.03	8.68	9 to 11	2.50	3.04	3 to 3½	1.97	2 to 2½	22.98
	10.66	1.20	7.22	2.06	9.28		2.09	2.54		1.45		21.64
	11.68	1.69	6.52	1.82	8.34		2.52	3.06		1.89		22.51
56	12.97	2.79	6.00	3.79	9.79	9 to 11	2.45	2.97	2½ to 3½	2.40	2½ to 2¾	24.63
	11.02	3.93	5.71	3.13	8.84		2.29	2.78		2.53		22.92
57	13.04	5.27	3.39	3.53	6.92		2.48	3.01		2.11		20.74
	13.26	3.63	4.61	4.32	8.93	9	1.58	1.92	1.50	1.51	1.25	19.26
	13.93	3.33	5.91	3.34	9.25		1.75	2.12		1.37		20.18
58	13.94	2.20	4.85	3.79	8.64	9	1.50	1.82	2	2.22	2	19.28
	12.53	3.06	4.43	3.36	7.79		1.45	1.76		2.73		18.49
59	15.80	1.07	8.14	3.29	11.43	11 to 13	----	----	---------	----	---------	14.86
	13.28	2.33	9.16	3.76	12.92		----	----	---------	----	---------	16.80
	13.63	2.66	10.49	2.42	12.91		....	----	---------	----	-------	16.78
60	16.60	1.45	7.74	2.27	10.01	9.45	2.14	2.60	2.40	1.19	1	22.52
61	15.42	2.92	6.27	2.17	8.44	8 to 10	2.43	2.95	2 to 2½	1.94	1 to 1¼	22.35
	13.75	3.80	6.19	3.26	9.45		1.71	2.08		1.53		20.47
62	15.63	2.01	7.39	0.90	8.29	8 to 10	2.26	2.74	2 to 3	1.97	$1\frac{4}{10}$ to 2	21.52
63	15.84	1.71	7.71	0.94	8.65	8½ to 11	2.35	2.85	2½ to 3½	3.20	1½ to 2½	23.57
64	15.67	1.85	7.00	1.38	8.40	7 to 8	1.83	2.22	1⅞ to 2	1.52	1½ to 1⅔	19.54
	14.95	2.05	7.16	1.78	8.94		1.59	1.93		1.62		19.43
	16.80	1.87	6.10	1.39	7.49		1.53	1.86		1.43		17.11

Station No.	NAME.	ADDRESS OF MANUFACTURER OR GENERAL AGENT.	SAMPLED AT	
4335 4404	Star Brand Special Tobacco Manure,	Allison & Addison, 1322 Cary st., Richmond, Va.,	Durham	65
4295	Stono Acid Phosphate	Stono Phosphate Co., Charleston, S. C.,	New Berne	66
4293	Stono Soluble Guano	Stono Phosphate Co., Charleston, S. C.,	New Berne	67
4405	Tinsley's Tobacco Fertilizer,	Jas. G. Tinsley & Co., 1326 Cary st., Richmond, Va.,	Reidsville	68
4331	Walker's Acid Phosphate	Joshua Walker, 13 German st., Baltimore, Md.,	Salisbury	69
4343	Walker's Ammoniated Phosphate,	Joshua Walker, 13 German st., Baltimore, Md.,	Salisbury	70
4308 4362 F 4562	Wando Acid Phosphate	Wando Phosphate Co., Charleston, S. C.,	Raleigh Concord Shelby	71
4403 F 4560	Wando Soluble Guano	Wando Phosphate Co., Charleston, S. C.,	Gastonia Shelby	72
4347 F 4533	Wilcox, Gibbs & Co.'s Manipulated Guano,	Wilcox & Gibbs Guano Co., 78 E. Bay st., Charleston, S.C.,	Clarkton Liberty	73
4400	Wilcox, Gibbs & Co.'s Superphosphate,	Wilcox & Gibbs Guano Co., 78 E. Bay st., Charleston, S.C.,	Liberty	74
4304	Zell's Ammoniated Bone Superphosphate,	Zell Guano Co., 30 S. street, Baltimore, Md.,	Selma	75
4312	Zell's Cotton Acid Phosphate,	Zell Guano Co., 30 S. street, Baltimore, Md.,	Raleigh	76
.....	Zell's Tobacco Fertilizer	Zell Guano Co., 30 S. street, Baltimore, Md.,	.....	77

	Water.	Insoluble phos. acid.	Soluble phos. acid.	Reverted phos. acid.	TOTAL AVAILABLE PHOSPHORIC ACID.		Nitrogen.	EQUIVALENT TO AMMONIA.		POTASH.		Relative com. value per ton at the Seaboard.
					Fou'd	Guarant'd		Fou'd	Guarant'd	Fou'd	Guarant'd	
65	11.40	4.18	4.64	4.70	9.34	8 to 10	2.40	2.91	2½ to 3	1.62	1½ to 1¾	$ 23.07
	15.06	2.46	7.50	1.50	9.04	8 to 10	2.52	3.06	2½ to 3	1.35	1½ to 1½	22.89
66	12.09	1.82	10.53	2.13	12.66	10	....	....	....	0.95	1	17.41
67	11.47	1.36	9.07	0.66	9.73	8	2.63	3.19	2	1.37	1	24.23
68	14.08	0.87	5.03	1.87	6.90	7 to 9	3.40	4.13	4 to 5	5.25	5 to 6	27.44
69	15.98	3.70	5.81	4.61	10.42	12	....	....	....	....	....	13.55
70	12.28	3.79	3.36	4.11	7.47	8 to 10	1.75	2.12	2½ to 3	1.32	1¼ to 1¾	17.81
71	15.40	2.21	7.41	2.97	10.38		....	....	....	....	....	13.51
	13.05	3.84	8.98	2.56	11.54	10						15.00
	10.44	4.50	9.26	2.93	12.19							15.85
72	12.18	2.79	8.03	1.59	9.62	8	1.84	2.23	2	1.80	1	21.45
	10.89	2.53	7.34	2.74	10.08		1.87	2.27		1.61		21.98
73	14.85	1.18	5.14	2.06	7.20	8	2.50	3.04	2½	2.93	2	22.02
	13.83	1.01	3.98	3.47	7.45		2.15	2.61		3.06		21.10
74	13.05	0.91	5.13	2.77	7.90	9	....	....	....	3.26	3	13.53
75	12.91	3.36	5.85	2.11	7.96	8 to 10	1.97	2.39	2 to 2½	1.47	1 to 2	19.47
76	15.06	1.69	9.21	2.14	11.35	13 to 15	....	....	....	0.80	1 to 2	15.56
77	....	....	....	....	....	....	....	....	....	....	....	.....

4554. Orchilla Guano sold by S. W. Travers & Co., Richmond, Va. Sample taken by the Inspector of Fertilizers at Salisbury gave the following analysis:

Moisture	13.33
Matter Insoluble in Acid	0.89
Carbonate of Lime	38.01
Total Phosphoric Acid	15.48
Equivalent to Phosphate Lime	33.81

MARLS, LIMESTONES, AND PHOSPHATES.

The Station has received and analyzed the following samples of marls during the year, representing beds in the various sections of the State:

4278. J. W. Quinerly, Johnson's Mills, N. C. White marl. Was dug from Clay Root swamp, on the lands of W. H. Clark. Depth of bed below the surface eight feet; extent of bed 20x30. Thirty-five hundred bushels thrown out. The marl never has been dug through. It seems the same ten feet deep.

4281. J. W. Boss, Rocky Mount, N. C. Blue marl. He writes: "I do not know the extent, for it is under the bed of Compass creek, which empties in Tar river about six miles from where I live in Nash county. Has been worked eighteen feet deep and did not go through the bed."

4284. J. M. Mayo, Whitakers, N. C. Marl, white powder. "The hard or lumpy portion lies about three feet under the pulverized portion. Considerable quantities of it can be had."

4285. Hon. E. C. Blount, Willow Green, N. C. Marl, white shell.

4297. Dr. J. M. Hayes, Barnitz, N. C. Shell marl. "There is an almost unlimited quantity of it on my place, having been deposited by a settlement of Indians in pre-historic times. The farmers in this locality speak very highly of its use, especially in low lands. It is deposited in a bank from three to four feet deep, covering a space of several acres, and can be reached easily by vessels on the Chowan river. It forms part of the shore of the river in a few feet of a wharf. There is quite an intermixture of decaying Indian bones in the marl."

4321. B. Witherington, Faison, N. C. White marl. He writes: "The beds are on my farm in Duplin county, N. C., and fourteen miles from Mt. Olive, N. C. No. 1. Bed is very extensive, as I think it extends for at least 1,000 yards down a creek through my farm."

4327. Dr. J. C. McCormick, Lillington, N. C. Supposed marl.

4359. Jno. P. Gray, Snow Hill, N. C. Blue marl. "Is located on Tyson's marsh, about five miles southwest of Snow Hill. The extent unknown, as I have been unable to make a thorough investigation. More than ever will be dug out. I did not go through in the bed I did dig. I went down about eleven feet, six feet in the marl and about five feet before I reached it. It was bored up in several other places. Mr. L. J. H. Mewborn has plenty of it just opposite this bed. I dug across the marsh, and had it analyzed by the Station, number of analysis 2322, date of letter to Mr. Mewborn, January 23, 1884, contained phosphate of lime 24.82 per cent., Some places it is under rock so I cannot bore through to it."

4364. B. Witherington, Faison, N. C. Blue Marl. No. 2 "Is located on my farm in Duplin county, N. C., and is fourteen miles from Mt. Olive, N. C. The bed is not so extensive as that of No. 1."

4365. B. Witherington, Faison, N. C. White marl. "Is located on my farm in Duplin county, N. C., and is fourteen miles from Mt. Olive, N. C. The bed is more extensive than numbers 1 or 2."

4373. W. B. Southerland, Rose Hill, N. C. Marl. "It is found two miles S. E. of Rose Hill. It is found at a depth of one and a half to three feet under surface; don't know how deep it is; have never dug more than four feet down. There are three different kinds: first is a fine yellow, and at a distance looks like sulphate potash; the second is the sample which appears to be of fine bones; the third is shell marl. This marl bed is on a tributary of Island Creek swamp, three quarters of a mile from the mouth of branch."

4394. C. H. King, Tarboro, N. C. Marl. He writes: "Is on my place about three miles from Tarboro. It is in a ravine, running from Tar river, extending forty or fifty yards into the field. I have never been able to cut through the bed, but have cut thirteen feet when it caved. There is a strata of light or red marl of about three feet over this bed. This bed extends to length of ravine and is found plentifully on the river when the water is low."

4413. Ashley Wilkins, South Gaston. Blue marl. He writes: "I found the sample near (one mile off) Palmyra, in the extreme lower edge of Halifax county, on the Roanoke river. It juts out on the river and seems to run back about a quarter of a mile or so from the river, judging from the hill."

4424. Col. Thos. S. Kenan, Raleigh, N. C. White marl. From Stephen Graham, Kenansville, N. C.

4425. Col. Thos. S. Kenan, Raleigh, N. C. Green marl. From Stephen Graham, Kenansville, N. C.

4459. W. R. Williams, Falkland, N. C. Marl. "Came from hill on my farm about one mile from Tar river, on Otter creek one-half mile. It has a slightly bluish look but clear."

4460. E. B. Hodges, Tarboro, N. C. Marl.

4461. E. B. Hodges, Tarboro, N. C. Marl.

4467. L. Harvey, Kinston, N. C. White marl.

4468. L. Harvey, Kinston, N. C. Blue marl. It came from a bed on his place situated five miles from Kinston, south side of Neuse river. "The bed is about three-quarters of a mile from Caswell Depot, A. & N. C. R. R. I think there are five or six acres of the marl. The bed is in Jones county, just over the Lenoir line. We have opened four pits. One pit we cut seven feet in marl and struck no rock. The dirt covering the marl is from two to six feet deep. There are many thousand tons in the bed. The bed is connected with 112 acres of fine farming land. There are two public roads running near the bed, one about 100

yards, the other about 250 yards. Think we have three or four acres more of marl on a branch running into Cabin branch."

4482. F. S. Stickney, Yeatesville, N. C. Sand marl. Who writes: "My farm is a clearing of 200 acres in Laurel swamp, on the north side of Pamlico river, in the eastern part of Beaufort county. All this section, bordering as it does on the Great Dismal, is a high land alluvion, beneath which is a three foot strata of marl of a similar quality to the sample I send to-day."

4483. Jethro Howell, Walters, N. C. Blue marl.

4484. Jethro Howell, Walters, N. C. Marl.

4485. J. M. Hayes, Barnitz, N. C. Shell marl. He writes: "I think there are at least 10,000 tons of the shells."

4486. Dr. A. B. Nobles, Tarboro, N. C. No. 1. Greyish color. "The marl sent was from my farm eight miles west of Tarboro, and on a very small branch running up in my farm. I accidentally found that it was good by digging some several yards back and putting it on some very poor land, and it filled me with surprise, and since then I have used it on several places on my farm, and always with marked results. I am sure it covers one, two or more acres, and possibly several. It is about four feet from top of ground and about six feet deep, and may be more. The four samples came from same bed, but are different layers, as there seemed to be a difference in composition and color. The layers are about eighteen inches thick and the No. 1 came from the top, although at the bottom it is about the same, and now I am inclined to think, after going through the soft substance, I may get some that is richer. There are cliffs all through the marl bed, but in the middle of the bed comes the dark marl, but that is not very extensive. I am satisfied that the marl has done much good to the land, as it is about the best land I have. Will make most anything."

4487. Dr. A. B. Nobles, Tarboro, N. C. No. 2. Yellow marl. Came from same bed as No. 4486.

4488. Dr. A. B. Nobles, Tarboro, N. C. No. 3. Shell marl. Came from same bed as 4486, third layer.

4489. Dr. A. B. Nobles, Tarboro, N. C. No. 4. Marl. Came from same bed as 4486, fourth layer.

4504. N. A. Pursser, Vanceboro, N. C. Marl. "This marl bed, I know, underlies or underbeds about five or six acres of swamp land. The swamp is one of Swift Creek's tributaries. It has been reached in many places of the bed with an augur. The marl has been penetrated at a depth of two and a half feet with an augur. Have not made a success digging, owing to the very wet condition of the land after it was found last fall. It lies from six to eight feet under ground, and no sand to bother. It is from one and three-quarters to two miles from Vanceboro. The sample I sent I do not think is a fair sample, as it was obtained from near the surface of the bed."

4522. Marl. T. H. Battle, Rocky Mount, N. C.

4524. C. F. Warren, Washington, N. C. Marl. "Came from Mr. Sharendon's farm, in Beaufort county. It is one mile east of the village of Yeatesville. The bed covers an area, as far as developed, of thirty or forty acres. It has been tried on lands that were perfectly dead, and in consequence it produced fine crops of corn and cotton without the use of other fertilizers. This marl is found at a depth of sixteen inches from the surface, and has been dug to a depth of nine feet. How much deeper the bed goes, has not been ascertained, in consequence of the water. Is found in lumps from the size shown, up to size of fist. It is found about eighteen inches from the surface of the earth."

4525. C. F. Warren, Washington, N. C. Marl. "Came from same bed as that of No. 4524. Underlies it and is found in a solid bed. This strata is about eighteen inches thick."

4526. Marl. C. F. Warren, Washington, N. C. "Came from same bed as Nos. 4524 and 4525. It underlies No. 4525, and is in a mass of shells three and a half feet through, and is mixed with earthy substance, as in sample. The shells are in a much larger proportion."

4527. Marl. T. W. Stokes, Johnson's Mills, N. C. "Located on west side of Clay Root swamp, flat lands. Extent of bed, as far as been, I suppose ten or twelve acres. Depth to the marl from four to six feet. I have been twelve feet down and have never been through."

4590. Green sand marl. D. W. C. Benbow, Greensboro, N. C. "The bed from which the sample of marl was taken, is this side of West Point, Va., on the Pamunkey river. It is very extensive, large quantities, very accessible, being a high bank by the side of deep water, obtained by digging and being allowed to fall in a boat. Owned by a company of which Peter H. Adams, of West Point, is a member."

4517. Limestone. W. A. Lash, Walnut Cove, N. C. He writes: "This piece of limestone was taken from the lands of the widow of Calvin Morris, two miles from the line of the C. F. & Y. V. R. R., and four miles west of Walnut Cove, Stokes county."

4518. Limestone. Dr. W. A. Lash, Walnut Cove, N. C. He writes: "The piece of limestone was taken from the land of A. H. Morris, on the C. F. & Y. V. R. R., one mile east of Germantown, in Stokes Co."

4377. N. C. Lime Phosphate. P. M. Wilson, Raleigh, N. C.

4429. Phosphate Rock. Col. Geo. Z. French, Rocky Point, N. C., who writes, "They are undoubtedly the most promising specimens yet discovered in North Carolina. Located in southeastern section of North Carolina. Not sufficiently explored to determine extent. It is probably a large bed, but it is so deep from the surface and so far from good facilities for railroad or water transportation, that it is doubtful if it can be worked successfully for some years to come."

4430. Phosphate Rock. Col. Geo. Z. French, Rocky Point, N. C. Came from same place as No. 4429.

4442. Phosphate Rock. R. W. Hicks, Wilmington, N. C. Found near Wilmington.

4536. Phosphate Rock. N. W. Powers, South Washington, N. C. "It was taken from my farm on the northeast branch of the Cape Fear river, one mile from the W. & W. R. R., in the upper end of Pender county. The rocks lie on and near the surface of the ground and cover one or two hundred acres of land."

4594. Phosphate. Marmaduke Hawkins, Raleigh, N. C.

4595. Phosphate. Marmaduke Hawkins, Raleigh, N. C.

No.	KIND.	COUNTY.	SENDER AND ADDRESS.	Sand & insol. matter.	Carbonate of lime.	Phosphate of lime.
4278	White Marl	Pitt	J. W. Quinerly, Johnson's Mills	41.45	51.13	.25
4281	Blue Marl	Nash	J. W. Boss, Rocky Mount	78.22	2.59	.50
4284	Marl, white powder	Edgecombe	J. M. Mayo, Whitakers	2.98	94.19	.....
4285	White Shell Marl	Greene	Hon. E. C. Blount, Willow Green	56.66	25.27	3.91
4297	Shell Marl	Chowan	Dr. J. M. Hayes, Barnitz	1.24	95.12	.....
4321	White Marl	Duplin	B. Witherington, Faison	14.45	81.25	.50
4327	Supposed Marl.	Harnett	Dr J. C. McCormick, Lillington	.....	.....	... .
4359	Blue Marl	Greene	Jno. P. Gray, Snow Hill	59.74	.25	19.84
4364	Blue Marl	Duplin	B. Witherington, Faison	80.58	8.26	.25
4365	White Marl.	"	" " "	20.63	74.49	.25
4373	White Marl.	"	W. B. Southerland, Rose Hill	15.41	76.38	.25
4394	Yellow Marl	Edgecombe	C. H. King, Tarboro	34.04	59.48	.25
4413	Blue Marl	Halifax	Ashley Wilkins, South Gaston	71.72	10.12	3.24
4424	White Marl	Duplin	Col. Thos. S. Kenan, Raleigh	18.37	71.15	0.95
4425	Green Marl.	"	" " " " "	69.94	1.14	4.69
4459	Marl	Pitt	W. R. Williams, Falkland	83.00	6.91	1.09
4460	Marl	Edgecombe	E. B. Hodges, Tarboro	45.68	49.81	2.82
4461	Marl	"	" " "	68.18	23.08	3.27
4467	White Marl	Lenoir	L. Harvey, Kinston	89.10	5.44	.....
4468	Blue Marl	Jones	" " "	25.71	71.76	.50
4482	Sand Marl	Beaufort	F. S. Stickney, Yeatesville	85.39	12.42	.....
4483	Blue Marl	Wayne	Jethro Howell, Walters	78.10	.10	.....
4484	Marl	"	" " "	88.39	.10	.....
4485	Shell Marl	Chowan	J. M. Hayes, Barnitz	1.75	91.89	1.82
4486	Grey Marl	Edgecombe	Dr. A. B. Nobles, Tarboro	54.71	8.23	22.32
4487	Black Marl	"	" " " "	70.96	2.75	4.44

No.	KIND.	COUNTY.	SENDER AND ADDRESS.	Sand & in-sol. matter.	Carbonate of lime.	Phosphate of lime.
4488	Shell Marl.....	Edgecombe....	Dr. A. R. Nobles, Tarboro.....	37.41	39.01	11.34
4489	Marl	"	" " " "	55.98	27.59	7.52
4501	Marl	Craven.....	N. A Pursser, Vanceboro	38.88	48.20	.20
4522	Marl	Edgecombe.....	T. H. Battle, Rocky Mount.....	2.86	93.42	.....
4524	Marl	Beaufort.....	C. F. Warren, Washington.....	30.76	62.57	.10
4525	Marl	"	C. F. Warren, Washington.....	80.25	5.73	.....
4526	Shell Marl.....	"	C. F. Warren, Washington.....	76.10	12.42	.25
4527	Marl	Pitt	T. W. Stokes, Johnson's Mills...	28.11	53.70	.50
4590	Green Sand Marl	Virginia.....	D. W. C. Benbow, Greensboro...	79.76	7.80	1.34
4517	Limestone.....	Stokes	Dr W. A. Lash, Walnut Cove...	43.58	53.05	.....
4518	Limestone.....	"	Dr. W. A. Lash, Walnut Cove...	49.58	42.74	.....
4377	N. C. Lime Phosphate	Wake.....	P. M. Wilson, Raleigh.....	.....	.....	12.13
4429	Phosph'te Rock		Col. G. Z. French, Rocky Point	.....	.....	49.48
4430	Phosph'te Rock		Col. G. Z. French, Rocky Point..	.....	.....	54.76
4442	Phosph'te Rock	New Hanover	R. W. Hicks, Wilmington.....	.....	0.50	.....
4536	Phosph'te Rock	Pender.....	N.W.Powers, South Washingt'n	51.46	.....	10.06
4594	Phosphate.....	....	Marmaduke Hawkins, Raleigh	.....	59.34	19.36
4595	Phosphate.....	.....	Marmaduke Hawkins, Raleigh	.....	16.17	64.65

HOME-MADE FERTILIZERS AND COMPOSTS

AND THE INGREDIENTS USED IN THEM.

The great number of requests which the Station receives for information on this subject shows that these practices are increasing rapidly throughout the State. The Station is always glad to give information about farm materials and the methods of producing manures, and no one should pay anybody for formulas when they can get from us, free of charge, any number of them for utilizing to best advantage, in fertilizing, all kinds of refuse material.

The subject is one of the most important which the farmer has to deal with—an item which, if he will attend to and utilize properly, will add many a dollar to the credit side of his balance-sheet at the end of the year, bringing peace and happiness to him and his family, with the knowledge that the work of the year has not been profitless; if, however, he has not taken care of this very important branch of the farm economy, then so surely will he be the loser.

The subject of home-made manures involves unquestionably the saving or losing of money on the part of the farmers, according to whether they have utilized in the best way the various home products and cared for them to the best advantage. Making home-made manures means money in your pocket. Wasting home-made manures means money in somebody else's pocket.

It is known from the results of numerous experiments that phosphoric acid, ammonia and potash in various proportions are necessary for the plant's growth. All of these can be obtained from the waste products of every farm. Potash, for instance, is found largely in wood ashes, forming a large

part by weight of the whole. In every one hundred pounds of oak wood ashes there are nearly ten pounds of potash, and besides five pounds of phosphoric acid. It is not generally known that a pound of unleached oak wood ashes contains more fertilizing constituents than a pound of kainite, and yet how many bushels of ashes are thrown away every year on every farm. The old adage, "a penny saved is a penny made," is a true one, and many a household would be happier, more contented, and richer, if they considered it in their every day life. Other refuse matters, yielding fertilizing materials, might be mentioned, among which are stable manure, hen manure, swamp muck, pond mud, river or creek sediment, shells, marls, tobacco stems, all organic vegetable matter furnishing ammonia, such as leaves, pine straw, etc.; also ashes, leached or unleached, dried blood, dried meat of every description, dried fish, bones and others. Each one of these is valuable and means dollars and cents to the farmer if it is saved. Every pound of these ingredients added to the soil will be valuable to the growing crop and for the future.

One leading object of the Station's work is to discover and bring to the attention of the farmers every material in the State which can be profitably utilized for improving our soils. This was the object of our phosphate and marl explorations, and the reason we analyze all kinds of farm refuse, mucks, home manures, cotton seed products, &c.

INGREDIENTS FOR FERTILIZERS AND COMPOSTS.

The Station makes analyses for actual farmers of all kinds of ingredients, of fertilizers, and composts. During the past year we have made the following analyses of such things, and the average composition of the ingredients now upon our markets may be judged from them. Analyses of simple superphosphates or acid phosphates will be found in the preceding table.

BONE MEAL, DISSOLVED BONE, AND BONE ASH.

4274. Bone Meal, sent by Thos. H. Blount, Esq., Washington, N. C.

4490. Bone Meal, sampled by Mr. D. H. Coble, Tabernacle, N. C. First-class meal.

4491. Bone Meal, ground by Lister's Agr. Chemical Works, sample sent by T. B. Parker, Esq., Goldsboro. High grade bone meal.

4509. "Bone Meal," ground by Mr. Harmond, of High Point, and sample sent by Mr. G. T. Glascock, Greensboro. Is probably a mixture of bone meal and raw phosphate.

4549. "Dissolved Bone," sent by Messrs. E. H. & J. A. Meadows, New Berne. Is really not dissolved bone, but dissolved S. C. Phosphate rock.

4433. Bone Ash, prepared by Shoemaker & Co., sample sent by the Experiment Station.

Station No.	NAME AND SENDER.	Total Phosphoric Acid.	Nitrogen.	Equivalent to Ammonia.
3598	Bone Meal sent by Capt. James F. Johnston, Charlotte	15.34	3.25	3.95
3822	Bone Meal, Commissioner of Agriculture	14.72	2.97	3.61
4274	Bone Meal, Thos. H. Blount, Esq., Washington, N.C.	19.05	3.86	4.69
4490	Bone Meal, D. H. Coble, Tabernacle, N. C.	20.24	3.97	4.82
4491	Bone Meal, T. B. Parker, Goldsboro	23.14	3.43	4.16
4509	Bone Meal, G. T. Glascock, Greensboro	25.01	1.35	1.64
4549	"Dissolved Bone," so-called, E. H. & J. A. Meadows, New Berne, is really dissolved S. C. Phosphate	....	.13	.16
4433	Bone Ash, Experiment Station, contains also 0.43 per cent. Potash	31.74	.48	.58

NITROGENOUS INGREDIENTS.

4412. Porpoise Scrap, sent by D. Bell & Co., New Berne.

4417. Fish Scrap (Menhaden), sent by D. Bell & Co., Morehead City.

4539. Tankage, Dr. W. J. Gascoyne, Richmond, Va.

4547. Fish Scrap, sent by E. H. & J. A. Meadows, New Berne.

4589. Tankage, sent by Dr. W. J. Gascoyne, State Chemist, Richmond, Va.

4280. Muck, from Henry N. Clark, Littleton, N. C.

4458. Muck, sent by J. V. Price, Hogan, N. C.

No.	NAME.	SENDER.	Total Phosphoric Acid.	Nitrogen.	Yielding Ammonia.	Potash.
4412	Porpoise Scrap	D. Bell & Co., New Berne	3.47	8.95	10.87	2.62
4447	Fish Scrap (Menhaden)	D. Bell & Co., Morehead City	7.01	8.96	10.88	---
4539	Tankage	Dr. W. J. Gascoyne, Richmond	14.32	....	....	---
4547	Fish Scrap	E. H. & J. A. Meadows, New Berne,	....	7.96	9.66	---
4589	Tankage	Dr. W. J. Gascoyne, State Chemist, Richmond, Va.	....	7.86	9.54	---
4280	Muck	Henry N. Clark, Littleton	....	.24	.29	---
4458	Muck	J. V. Price, Hogan, N. C	....	.54	.66	---

COTTON SEED MEAL.

4271. Cotton Seed Meal (fresh), sent by Thos. H. Blount, Esq., Washington, N. C. Ground by Washington Mill.

4272. Cotton Seed Meal (fresh), sent by Thos. H. Blount, Washington. Ground by New Berne Mill.

4273. Cotton Seed Meal (12 months old), sent by Thos. H. Blount, Washington. Ground by Elizabeth City Mill.

4287. Cotton Seed Meal, ground by Goldsboro Oil Co.

4357. Cotton Seed Meal, sent by F. S. Royster. Ground at Tarboro Oil Mills.

4397. Cotton Seed Meal, Raleigh Oil Mill and Fertilizer Co.

4420. Cotton Seed Meal, sent by James McBryde, Floral College, N. C.

4548. Cotton Seed Meal, sent by E. H. & J. A. Meadows, New Berne.

4573. Cotton Seed Meal (made from new seed), ground by Tarboro Oil Mills.

4574. Cotton Seed Meal (made from old seed), ground by Tarboro Oil Mills.

NO.	NAME.	SENDER.	Nitrogen.	Equivalent to Ammonia.
4271	Cotton Seed Meal (Fresh),	Thos. H. Blount, Washington, Washington Mills,	6.33	7.68
4272	Cotton Seed Meal (Fresh),	Thos. H. Blount, New Berne Mills,	6.87	8.34
4273	Cotton Seed Meal (12 months old),	Thos. H. Blount, Elizabeth City Mills	6.35	7.71
4287	Cotton Seed Meal,	Goldsboro Oil Mills	6.95	8.44
4357	Cotton Seed Meal,	Tarboro Oil Mills	7.70	9.35
4397	Cotton Seed Meal,	Raleigh Oil Mills	7.59	9.21
4420	Cotton Seed Meal,	Jas. McBryde, Floral College	7.49	9.09
4548	Cotton Seed Meal,	E. H. & J. A. Meadows, New Berne	7.24	8.79
4573	Cotton Seed Meal (New Seed),	Tarboro Oil Mills	6.78	8.23
4574	Cotton Seed Meal (Old Seed),	Tarboro Oil Mills	6.66	8.09

EXCHANGE OF COTTON SEED FOR MEAL.

Now that cotton seed oil mills are increasing in our midst, and cotton seed are desired for the extraction of oil, the question is often asked if it would be advantageous for the farmers to exchange cotton seed for cotton seed meal in the proportion of two tons of the former for one ton of the latter. This can be answered without doubt in the affirmative.

In 100 pounds cotton seed there are, on an average, almost exactly 50 pounds hulls and 50 pounds kernels; or, in other words, in cotton seed one-half are hulls and one-half are kernels. From the 50 pounds kernels, 10 pounds (on an average) of oil are extracted, leaving 40 pounds cake, which when ground furnishes the meal. So in every 100 pounds seed sold there are 40 pounds of meal.

The cotton seed loses none of its fertilizing quality by being crushed to liberate the oil—in fact, it gains thereby, as the oil is in no sense useful as a manure, and the hull contains but a small amount of fertilizing ingredients.

The oil is composed of the chemical elements, carbon hydrogen and oxygen combined together in a very complicated arrangement. A different arrangement of these same elements would form ordinary sugar, a piece of cotton cloth, or a drink of whiskey. The water we drink is made of the last two, hydrogen and oxygen, and the carbon is found in large quantities, combined in different ways, in both the atmosphere and the soil. In fact, all three of these elements are found in abundance, both above and below the surface of the ground. The cotton plant has the power in its growth of taking up these elements through the pores of its leaves from the air and through each little rootlet from the soil, and rearranging them to form the fiber of the stalk and the oil of the seed.

The carbon comes almost entirely from the air, the hydrogen and oxygen (mainly in the form of water) from both air and soil, and consequently neither can be said to have any fertilizing property, either alone or combined to form the oil.

An average of many analyses of cotton seed give in every 100 pounds, 1.14 pounds of phosphoric acid, 3.03 pounds of ammonia, and 1.18 pounds of potash.

The meal is by far the most valuable portion of the seed, and contains more fertilizing ingredients than in all the other portions together. It is the valuable (agriculturally) concentrated portion of the seed, from which all the comparatively valueless parts have been separated. It contains more fertilizing properties than the best commercial ammoniated fertilizer, but as they are not combined in the right proportion, we must mix other ingredients to give the proper contents of phosphoric acid, ammonia and potash for a complete manure.

An average of many analyses of cotton seed meal made in the Laboratory in the past, gives in 100 pounds meal, 2.80 pounds phosphoric acid, 8.60 pounds ammonia, and 1.61 pounds potash. We see, therefore, meal contains about four times as much ammonia, in comparison with a commercial fertilizer, an almost equal amount of potash, but a deficiency in the amount of phosphoric acid. The hull of the cotton seed contains also, but in very small quantities, ammonia, potash and phosphoric acid.

It is the custom of the oil mills to give one ton of meal in exchange for two tons of seed, and in some cases, where competition is sharp, have paid the freight on the seed sent to them. Let us enquire if this is a fair exchange.

We have seen that in the 100 pounds of seed there were left, after the oil had been expressed, 40 pounds meal. Therefore, in 4,000 pounds (2 tons) of seed there will remain 1,600 pounds meal; in other words, the farmer is given 400 pounds more of meal than the weight of meal in his two tons of seed.

As the meal is by far the most valuable as a fertilizer of any of the ingredients of the seed, a farmer can well afford to throw aside the comparatively valueless parts for the sake of getting this meal, especially if he receives more than he gives.

Let us look at the exchange from a chemical standpoint. By reference to the analysis of the whole seed already given, it can be seen that in two tons there are 45.60 pounds phosphoric acid, 121.20 pounds ammonia, 47.20 pounds potash.

If these ingredients are valued just as commercial fertilizers are valued now, for example, for phosphoric acid six cents, for ammonia fifteen cents, and for potash five cents per pound, and considering the phosphoric acid all available, the total would be $23.28.

On the other hand, one ton of cotton seed meal contains: 56.00 pounds phosphoric acid, 172.00 pounds ammonia,

32.20 pounds potash, which, when calculated as before, gives a valuation of $30.77.

So by the exchange the farmer gives fertilizing ingredients amounting to $23.28, and gets back ingredients amounting to $30.77, thereby making $7.49 by the transaction. Of course it is unnecessary to say that the oil mills make a profit in saving the oil, which is of no value to the farmer, and using the hulls, which are burnt under the engines as fuel.

It must not be forgotten, however, that when the exchange has been made, a large quantity of vegetable matter (the hulls of the cotton seed) has been lost to the soil, that is, if the whole seed had been applied to the soil, instead of the cotton seed meal, which is procured by the exchange.

As we saw, the hulls, roughly speaking, amount to one-half by weight of the whole cotton seed, so in the transaction one ton of hulls is thereby lost to the soil. This represents so much vegetable matter which should go back to the soil, when the meal is applied to the land for the purpose of fertilizing it. This vegetable matter may be supplied in the form of leaf rakings, vegetable mould or the like, and should not be forgotten when the compost is being made. It is quite essential that this vegetable matter should be applied to the soil, for it not only supplies ingredients valuable to the growing of the plant by decomposition, but it, by this very change lightens up the soil also, and fits it for the better development of the young sprout and the future stalk.

HOW TO PREPARE FARM MANURES.

In making up the manure for a crop, the farmer should be guided chiefly by two considerations. He must ascertain wherein the soil, upon which the crop is to be grown, is deficient, and he must know the requirements of the plant which is to live upon it. These matters are best ascertained by actual experiment, carried on by the farmer himself on

his own land, using different fertilizing ingredients to show him what elements are lacking. We will suppose that the farmer has determined what he is going to use, and how much per acre, and will endeavor to explain how different fertilizing materials are to be combined and prepared.

There are two distinct cases. In the one case, the plant food of the materials to be used is already in sufficiently available form, and the different ingredients need only to be well mixed in the proper proportions. In the other case, some of the materials need to be changed before they are put in the soil, and must be composted, or rotted. We will illustrate the method which will have to be used in each case by an example:

First. We will suppose that the materials do not need to be composted, but only mixed. Let us illustrate with the case of a cotton manure. We will suppose that it is a piece of poor, sandy land, upon which pine was the original growth, that it is desired to manure. The planter has ascertained by actual trials upon this land that he must supply a little of all the chief elements of plant food in order to make a paying crop. His experience teaches him that the most economical application is a manure that will enable him to apply conveniently twenty-five pounds of phosphoric acid, five pounds of ammonia and six pounds of potash per acre, and that it is an advantage to have a part of his ammonia in a form quickly available for the first demands of the plants, with a part more slowly available. He must take care, therefore, to mix the ingredients in these proportions.

Now to get the materials. The farmer looks around him to see where he can get them to best advantage. He has at home some mixed wood ashes, which have been exposed in part. He can get a lot of damaged cotton seed meal, and he sends to a distance and gets some dissolved phosphate rock, sulphate of ammonia and kainite. We will regard the ashes as containing four per cent. of potash and six per cent. of

phosphoric acid, and will suppose the damaged cotton seed meal contains six per cent. of ammonia. The dissolved phosphate rock will give twelve per cent. of available phosphoric acid, the sulphate of ammonia twenty-five per cent. of ammonia, the kainit twelve per cent. of potash. To get the desired amounts of phosphoric acid, ammonia and potash per acre, he must use the following amounts of each material:

Pounds per acre.	Pounds of Phosphoric Acid.	Pounds of Ammonia.	Pounds of Potash.
100 Ashes contain	6.	....	4.
150 Dissolved phosphate contain	18.	....	....
40 Cotton seed meal (damaged) contain	1.5	2.4	....
10 Sulphate of ammonia contain	....	2.5	....
20 Kainite contain	....	....	2.4
320 pounds contain	25.5	4.9	6.4

The ingredients are now to be mixed in these proportions. A thorough mixing is something not as easily accomplished as one may think. This is all important in order that each individual little rootlet may find within its reach all of the different agents whose good effects depend partly upon their simultaneous presence.

As a rule, chemical manures must be kept in a dry place. We will select a smooth place under a shed as our mixing floor, and, having crushed all lumps, will sprinkle down in this case, first a layer of ashes, then a layer of cotton seed meal with a little sulphate of ammonia and kainite, in the proportions decided upon, a layer of ashes, &c., until the materials are exhausted. The mass is then to be shoveled together, first into numerous little heaps, then into larger ones, until finally it is all brought together into one large pile.

HOW TO COMPOST MANURES.

Second. Some materials must be composted to render their

constituents more readily available to plants. The seeds of grasses, weeds, &c., in the litter must be killed. The manner of managing the compost differs so much with the different materials which enter into it that it is almost impossible to give any general directions on the subject.

We will have to take an example here, also, and suppose that it is desired to compost cotton seed with stable manure, and to combine with them enough bone and muriate of potash to make a manure for corn.

Rotted stable manure contains more soluble plant food and less water and insoluble mineral and vegetable matter than fresh. The best conditions for the rotting of stable manure are moisture and exclusion of air. On the one hand the heap should not be leached by the rain, and on the other it ought not to get dry or be open to the too free circulation of air.

We prefer a cement floor, or a tightly laid wooden floor, sloping from all sides to the centre, upon which to build the heap. This may well be under a roof, and there may be a covered trough to drain the pile into a tight box or barrel. A basin, scooped out in the ground down to the clay, will answer every purpose, and if the liquids do not soak or drain away, there is no objection to its being exposed to moderate rain. We will suppose that the materials are to be combined in the proportions, 22 bushels of cotton seed, or about 600 pounds, 600 pounds of stable manure, 700 pounds of bone meal and 100 pounds muriate of potash to the ton of 2,000 pounds. If the cotton seed are used first as an absorbent in the stalls along with the litter, a layer of bone meal should be sprinkled over each leayer of manure that is taken from the stalls. In the other case, we will soak the cotton seed in water in which the muriate of potash has been dissolved, and putting down a layer of stable manure over it, follow it by a layer of bone. Every few layers that are put down, the mass ought to be trampled or rammed down and well wetted with water or solution of the muriate of potash. The heap is built up in a conical form and covered over with earth.

leaving an opening in the top in which water can be poured. The pile will soon begin to ferment and get warm, and liquid will possibly drain from it into the barrel. This should be thrown back upon it and more water added, if it appears to get at all dry. The heap should lie at least six or seven weeks. When broken, it should be cut down through the layers and thoroughly chopped up.

How might we expect a sample of compost made from these materials in these proportions to analyze? We calculate from the ingredients used what amount of plant food there would be in a thousand pounds of the mixture, air-dried, as follows:

	Pounds of Phosphoric Acid.	Pounds of Ammonia.	Pounds of Potash.
350 lbs. Bone meal contain about	80.	12.	----
300 " Cotton seed contain about	4.5	9.	6.
300 " Stable manure contain about	1.5	1.5	1.5
50 " Muriate of potash contain about	----	----	25.0
1000 lbs contain about	86.0	22.5	32.5

The spreading of chemical manures also requires careful attention. If they are broadcasted by hand, they should be sown just as carefully as grain or grass seed. In case the whole surface is to be covered, the wheat drill may be used to spread the fine manures. The best way, unquestionably, to spread a compost is to use one of the excellent machines now made for the purpose.

FORMULAS FOR FARM MANURES.

The Station receives so many requests for formulas for mixtures and composts that we will give a few simply as suggestions and illustrations, using different farm materials and cheap chemicals. THE THOUGHTFUL FARMER WILL VARY THESE PROPORTIONS TO SUIT HIS INDIVIDUAL NEED.

We give a variety of formulas, each to make about one ton of fertilizer, so as to meet the requirements of the different sections of the State, and using, as far as possible, whole packages of the articles, so as to save weighing or measuring. In preparing these, we have had the corn and cotton crops more especially in mind, but the formulas will be found generally useful.

A.—FOR COTTON AND CORN.

I. DRY MIXTURES.

1. Tankage, ground ..... 600 lbs.
   Acid phosphate ..... 600 "
   Kainite ..... 300 "
   Sulphate of ammonia ..... 80 "
   Woods mould or fine rich earth ..... 420 "

Or use bone meal or ground fish in place of the tankage.

2. Mixture to make a home-made complete fertilizer for general use.
   Kainite ..... 200 lbs.
   Acid phosphate ..... 1,200 "
   Cotton seed meal ..... 600 "

3. Acid phosphate ..... 800 lbs.
   Muriate potash ..... 100 "
   Sulphate of ammonia ..... 60 "
   Finely pulverized manure from hen-house, horse or cow stables ..... 1040 "

These may all be used after the manner of commercial fertilizers.

II. COMPOSTS.

In preparing the composts, the formulas for which, are given below, the same general plan must be carried out in each. The mixing should best be made under shelter, and if that is not convenient, mix where it can be sheltered by thick trees, to protect from rain and weather, putting down first a layer of stable manure, then a layer of acid phosphate, and so on until all the materials are exhausted, wetting each layer thoroughly with water, and then with kainite dissolved in water. When the heap is finished it should be covered with earth. Examine from time to time, and if necessary moisten with water to prevent overheating. It is not likely that overheating will take place. If it does, it can be readily detected by a slight odor of ammonia evolved by the decom-

position of the organic matters of the compost. In about six weeks or more, the compost is ready for use, when it should be mixed as thoroughly as possible, when loaded in carts to be applied to the land. The cotton seed, if any had been used in the compost heap, should be thoroughly killed by the heat of the decomposition before being applied.

It is a hard matter to advise as to the proper quantity of each compost to be used to the acre. The farmer knows his own capabilities and resources, and should therefore be his own judge; he best knows how much money he can afford to spend in manures for application to the soil. The formulas given are all in the right proportion for general use, and for our purposes the general rule will hold for each, as, indeed, in all fertilization of land in this way: *The larger the quantity of composts applied to the acre, the greater will be the crop yield.*

1. Using cotton seed:

Stable manure	600 lbs.
Kainite	200 "
Acid phosphate	800 "
Cotton seed	400 "
One ton of	2,000 "

2. Using cotton seed meal:

Kainite	100 lbs.
Acid phosphate	600 "
Stable manure	600 "
Cotton seed meal or fish scrap	700 "
	2,000 "

3. Stable manure predominating:

Kainite	200 lbs.
Acid phosphate or bone meal	800 "
Stable manure with yard scrapings	1,000 "
	2,000 "

4. A cheaper formula:

Acid phosphate or bone meal	600 lbs.
Ashes	200 "
Stable manure	600 "
Rich earth or yard scrapings	600 "
	2,000 "

B.—FORMULAS FOR WHEAT, OATS, OR RYE.

1. Using cotton seed. The cost of this one is calculated as an illustration:

	Lbs.	Costs.
Acid phosphate, at $18 per ton	600	$ 5 40
Kainite, at $14 per ton	200	1 40
20 bushels cotton seed, at 16 cents per bushel	600	3 20
Stable manure, or any rich earth or mould	600	----
One ton of	2,000	$10 00

2. With chemicals:

Acid phosphate	1,000 lbs.
Sulphate of ammonia	100 "
Muriate of potash	100 "
Stable manure	800 "
	2,000

Where ground tobacco stems or dust, or cotton seed can be had, they may be substituted in whole or in part for the stable manure. Care, however, must be taken to kill the cotton seed in the compost heap.

When preparing mix in layers, dissolving the sulphate of ammonia and muriate of potash in water, and sprinkling it over each layer.

3. A cheaper formula:

Acid phosphate or bone meal	600 lbs.
Muriate of potash	100 "
Sulphate of ammonia	100 "
Dry muck or other rich earth	600 "
Stable manure	600 "
	2,000 "

4. Using cotton seed meal:

Acid phosphate	600 lbs.
Cotton seed meal	700 "
Stable manure	600 "
Muriate of potash	100 "
	2,000 "

C.—FORMULAS FOR TOBACCO.

1. A very strong mixture, using cotton seed meal:

Acid phosphate	900 lbs.
Sulphate of potash	200 "
Cotton seed meal	800 "
Sulphate of ammonia	50 "
Nitrate of soda	50 "
	2,000 "

2. A cheap, but good compost:

Acid phosphate	500 lbs.
Sulphate of potash	300 "
Sulphate of ammonia	100 "
Sulphate of magnesia	100 "
Land Plaster	100 "
Stable manure	900 "
	2,000 "

To insure bright tobacco, it is always advisable to use sulphate of potash, as in the above two formulas, instead of kainite or muriate of potash.

3. Same as the last, but substituting cotton seed for stable manure, and omitting sulphate magnesia:

Acid phosphate	500 lbs.
Sulphate of potash	300 "
Sulphate of ammonia	100 "
Land plaster	100 "
Cotton seed	1,000 "
	2,000 "

4. Fine horse or cow manure, rich mould or similar material 900 lbs.

Acid phosphate or dissolved bone	600 "
High grade sulphate potash	150 "
Fish scrap or tankage	350 "
	2,000 "

ANALYSES OF FARM MANURES.

As an encouragement and aid to farmers in preparing their own manures at home, the Station will determine the

per centages of the chief valuable ingredients in samples of farm composts and mixtures, if the samples are taken according to directions, which will be sent.

During the past year the following analyses of such samples have been made:

4277. Home-made mixture. Prepared by N. W. Crawford, Elizabeth City.

4318. Home-made compost, also from Mr. Crawford.

4366. Home-made mixture, from John L. Bailey, Toisnot.

Made by the following formula:

Cotton seed meal	1,000 lbs.
Sulphate ammonia	175 "
Sulphate potash	200 "
Acid phosphate	625 "
Total	2,000 "

The sample probably was a bad one, or the mixing imperfectly done, for the analysis is not as high as should be from the above formula.

4434. Home-made mixture, from Ransom Hinton, Raleigh. Mr. Hinton used cotton seed meal, acid phosphate, and kainite, and estimates the mixing, which seemed to be carefully done, at 50 cents per ton.

4443. Compost sent by the Experiment Station, made from acid phosphate.

4444. Compost sent by the Experiment Station, made from lime phosphate.

ANALYSES OF FARM MIXTURES.

NO.	NAME OF SENDER.	Moisture.	Volatile and organic matter.	Ash or mineral matter.	PHOSPHORIC ACID.					Nitrogen.	Equivalent to ammonia	Potash.
					Total	Soluble	Reverted	Insoluble	Available			
4277	N. W. Crawford, Elizabeth City,	.....	45.74	.....	10.54	.....	.....	2.99	7.55	2.37	2.88	5.54
4318	N. W. Crawford, Elizabeth City,	.....	39.26	.....	4.07	.....	.....	1.38	2.68	1.77	2.15	1.99
4366	Jno L. Bailey, Toisnot.	.....	49.66	.....	4.85	.....	.....	1 30	3.55	2.35	2.85	2.98
4434	Ransom Hinton, Ral'igh	6.70	54.94	38.36	8.99	.....	... .	1.39	7.60	3.58	4.35	1.10
4443	Exper. Station, Raleigh	21.58	13.18	65.23	1.23	.47	.47	.29	.94	.42	.51	.61
4444	Exper. Station, Raleigh	28.90	26.00	45.16	1 19	.....	.05	1.14	.05	.79	.96	1 31

Average Composition of Fertilizing Materials.

On the following pages will be found tables giving the average composition of fertilizing materials in common use, and those which may be utilized on every farm. These tables are inserted at the request of a prominent farmer of Cumberland county. It is believed that they will be found useful as well to all who study the needs of their soils and the value of home materials they are able to utilize. The tables are, in the main, adapted from those of a similar nature in the *Farmers' Annual*, an excellent pocket manual (which were printed in the Station report for 1881), and includes only American analyses from various sources. To the original list have been added the analyses of many other fertilizing materials obtained from the reports of various Experiment Stations, including the results of many analyses obtained in our own laboratory and published in the various reports of the past.

In the first three columns are given the per centages of water, organic and combustible matter, and ash. Where the determinations are all given, they will be found to add up to a hundred. To the right of the double line are given the per cents. of the various constituents which it is interesting to know.

Cost of Ingredients.—It is a difficult matter to give the exact cost of any of these ingredients. Many of them being commercial articles, are subject to the fluctuations common to all markets. And again, the cost is determined, in a great measure, by the locality, as well as by competition, and a variety of other causes. To give some idea, however, the following on the subject is inserted, taken from our Bulletin of February, 1888, which gives the price of the various articles at that time:

Ground Bone, 3 to 4 per cent. ammonia and 40 per cent. of bone phosphate, $35 in Raleigh, $30 in Baltimore.

Cotton Seed Meal, 9 per cent. ammonia, 5 per cent. bone phosphate, $24 at Raleigh.

Fish Scrap, 10 per cent. ammonia, 12 per cent. bone phosphate, $32 at the seaports.

Kainite, 12 per cent. potash, $14 in Raleigh.

Chemicals, sulphate of ammonia, 3¾ cents per pound in Baltimore; muriate of potash (85 per cent.) 2½ cents per pound; nitrate of soda, 3 cents per pound; sulphate of potash, 2½ cents per pound.

It is always advisable, when buying fertilizing ingredients of this nature, to have the dealer furnish a written guarantee of the goods he sells.

COMMERCIAL NAME.	Water.	Organic Matter.	Ash.	Nitrogen.	Equivalent to Ammonia.	Silica and Insoluble.	Alumina and Oxide of Iron.	Lime (oxide).	Magnesia.	Potash.	Soda.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.
Farm Manure and Factory Refuse:														
Stable Manure	71.3	15.6	13.1	0.5	0.6	10.5	0.7	0.5	0.3	0.4	0.1	0.1	0.5	0.1
Cotton Seed (whole)	....	....	3.7	2.8	3.0	...	....	....	...	1.2	....	....	1.14	....
Cotton Seed Meal	6.8	....	....	7.1	8.6	...	....	....	....	1.6	....	....	2.8	....
Hen Manure	58.0	16.3	25.7	0.8	.97	20.7	....	....	...	0.4	...	...	0.5	....
Night Soil—Poudrette	32.2	26.1	41.7	1.4	1.7	14.9	2.2	3.5	0.6	0.3	0.3	6.7	2.2	0.1
Swamp Muck, fresh	76.2	15.8	8.0	0.3	.36	6.8	1.4	0.4	....	....	....	....	....	....
Swamp Muck, air-dry, first quality	21.4	53.3	25.3	1.3	1.58	13.5	1.4	0.9	....	...	...	....	....	....
Pond Mud	13.0	7.1	79.9	0.2	2.4	74.8	4.4	0.3	0.6	0.2	0.1	0.2	0.1	....
Marine Mud	53.5	5.9	40.6	0.2	.24	36.8	3.6	1.8	0.5	0.2	0.3	0.5	0.1	....
Catch-basin Sediment	3.8	21.9	74.3	0.4	4.8	....	....	....	....	....	....	....	....	....
Gas Lime	4.4	10.5	85.1	0.3	0.36	5.1	3.4	40.9	11.0	....	....	4.1	....	....
Pine-straw (dead leaves of pines)	7.8	89.3	2.9	0.3	0.36	1.6	....	0.4	0.1	0.1	....	0.04	0.2	0.01
Spent Tan	14.0	84.2	1.8	0.2	.24	....	....	....	...	0.1	....	....	0.04	....
Ashes and Lime Manures:														
Wood Ashes	7.8	....	...	....	....	12.4	2.8	32.4	4.9	7.7	1.0	1.4	2.1	0.6
Leached Wood Ashes	31.5	....	....	....	....	11.8	2.1	29.3	3.0	1.1	0.4	0.1	1.5	0.1
Ashes of Cotton-seed Hulls	18.0	....	...	....	....	14.3	1.5	8.1	4.2	19.7	7.8	...	9.2	....
Ashes of Corn-cobs	...	....	....	....	....	27.8	7.5	....	..	23.2	....	....	....	....
Ashes of Bogs and Peat	5.2	...	....	....	....	51.1	7.6	26.1	3.1	0.7	0.4	4.2	0.5	0.2
"Agricultural" Lime (air-slaked Lime)	18.5	....	..	...	...	....	..	41.7	0.3	....	....	...	....	....
Lime-kiln Ashes	2.7	....	....	....	....	17.6	3.2	45.8	2.9	0.9	0.6	....	1.7	....
Oyster Shell Lime	19.5	....	...	....	....	7.6	1.4	57.3	0.3	0.1	0.2	0.5	0.2	....
New Jersey Green Marl, average of all	8.2	....	....	....	....	52.8	25.5	2.9	2.2	4.7	0.6	0.7	2.2	....

AVERAGE COMPOSITION OF FERTILIZING MATERIALS—CONTINUED.

COMMERCIAL NAME.	Water.	Organic Matter.	Ash.	Nitrogen.	Equivalent to Ammonia.	Silica and Insoluble.	Alumina and Oxide of Iron.	Lime (oxide).	Magnesia.	Potash.	Soda.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.
Shells of Mollusks (oysters, &c)	....	2.7	....	.10	.12	2.0	....	50.3	....	0.04	....	....	0.03	....
Land Plaster (gypsum)	....	....	....	....	....	3.4	....	54.7	....	....	....	41.9	....	....
Fertilizers Chiefly Valuable for their Nitrogen :*														
Nitrate of Soda, 95 per cent	1.8	....	....	15.7	....	....	....	....	....	....	....	....	....	1.4
Nitrate Soda, 97 per cent	....	....	....	16.0	....	....	....	....	....	....	....	....	....	....
Niter-cake	6.0	....	....	2.3	2.79	3.9	....	....	....	0.4	29.6	47.8	....	....
Sulphate of Ammonia, 98 per cent	....	....	....	20.0	24.3	....	....	....	....	....	....	....	....	....
Dried Blood	16.0	....	....	11.4	13.8	3.0	....	....	....	....	....	....	5.0	....
"Azotin"	10.1	....	....	10.7	13.0	....	....	....	....	....	....	....	6.9	....
Fish Scrap, North Carolina	....	....	....	7.9	9.6	....	....	....	....	....	....	....	8.0	....
Dry Fish Guano	15.7	....	....	7.8	9.5	....	....	7.0	0.7	3.0	1.0	....	6.9	....
Half Dry Fish Scrap	46.0	....	....	5.5	6.7	....	....	....	....	0.3	....	....	7.5	....
Castor-pomace	9.7	....	....	4.8	5.8	....	....	....	....	1.0	....	....	1.8	....
Tankage	....	....	....	6.3	7.6	....	....	....	....	....	....	....	12.4	....
Hoof and Horn Shavings	14.2	....	....	13.6	16.5	....	....	....	....	....	....	....	....	....
Hair Manures	32.0	....	....	7.2	8.7	....	....	....	....	....	....	....	1.9	....
Wool-waste	0.11	....	....	5.1	6.2	....	....	....	....	....	....	....	....	....
Potash Salts and Waste Products with Potash :†														
Chloride Potash (Muriate) 80 per cent. (commercial article)	....	....	....	....	....	....	....	....	....	50.5	6.7	....	....	49.4
Cloride Potash (Muriate) 84 per cent	....	....	....	....	....	....	....	....	....	53.1	....	....	....	....
Sulphate of Potash—high grade, 80 per cent	....	....	....	....	....	....	....	....	....	43.2	....	46.5	....	1.6
Sulphate of Potash—medium grade, 70 per ct	....	....	....	....	....	....	....	....	....	37.9	....	....	....	....
Sulphate of Potash—low grade, 60 per cent	....	....	....	....	....	....	....	....	....	31.9	....	11.7	....	34.7
Sulphate of Potash—acid	0.6	....	....	....	....	1.9	....	0.1	0.1	36.0	5.0	46.5	....	10.4

AVERAGE COMPOSITION OF FERTILIZING MATERIALS—CONTINUED.

COMMERCIAL NAME.	Water.	Organic Matter.	Ash.	Nitrogen.	Equivalent to Ammonia.	Silica and Insoluble.	Alumina and Oxide of Iron.	Lime (oxide).	Magnesia.	Potash.	Soda.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.
Kainite (containing Sul. Potash, 23.5 per ct.	....	....	....	....	....	....	4.2	....	8.8	13.1	17.2	15.9	....	26.3
Salpeter Waste	6.2	....	....	2.0	2.4	6.8	....	0.8	0.1	23.5	22.1	2.7	....	37.7
Tobacco Stems	12.7	74.8	12.5	1.8	2.2	1.2	0.1	3.6	0.1	5.2	0.2	0.6	0.5	....
Tobacco Dust	7.3	55.8	36.9	2.2	2.8	....	....	....	....	1.2	....	....	....	....
Phosphatic Materials:														
Bone Meal	....	....	....	3.2	3.9	....	....	....	....	....	....	....	22.5	....
Bone Black	9.9	8.1	82.0	....	....	1.6	....	....	....	....	....	....	33.1	....
Bone Ash	5.0	....	....	....	....	4.5	....	44.9	....	....	....	....	35.3	....
Canadian Apatite	....	....	....	....	....	....	....	....	....	....	....	....	34.6	....
Dissolved Bone (14.5 per cent. Available Phosphoric Acid)	....	....	....	2.2	2.7	....		....	....	....	....	....	15.7	....
Natural Phosphates:														
South Carolina Phosphate	..	....	....	....	....	....	....	....	....	....	....	....	26.0	....
North Carolina Phosphatic Marl	....	....	....	....	....	....	....	42.3	0.8	0.4	....	....	5.2	....
Curacao Guano	11.6	....	....	....	....	0.7	....	42.9	1.9	....	....	1.4	27.4	....
Orchilla Guano	7.4	....	....	....	....	....	....	40.8	2.6	....	....	2.2	23.8	....
Caribbean Sea Guano	10.4	....	....	....	....	....	0.5	....	37.9	....	....	....	26.2	....
Bat Guano	19.6	63.1	17.0	8.7	10.6	6.2	....	..	.	tr'ce	..	....	4.8	..

* See also Bat Guano and Peruvian Guano under "Phosphatic Materials."

†See also Ashes and Lime Manures.

THE NORTH CAROLINA STATE WEATHER SERVICE.

The State Weather Service, organized in December 1886, is now an accomplished fact. It has already accumulated much valuable meteorological data, which will be of permanent service to the State. In its weather indications, cold wave and frost warnings, it has distributed broadcast throughout the State information of great value to the farming population, as well as all classes of her people.

A State Weather Service has a two-fold duty:

1st. The collection of accurate, detailed weather statistics for the territory of a State; and 2d, the dissemination of practical information, weather "indications," and frost or cold-wave warnings.

The profession of farming is more interested in the weather than any other; and forecasts of the weather for twenty-four or forty-eight hours ahead will determine the commonest every-day operations on the farm.

Besides these ordinary benefits, which everybody will appreciate, North Carolina has unusually large interests in crops which frosts and freezes can destroy, and which may be saved if only a half a day's warning of cold is given. Our tobacco, truck and fruit interests have been frequently damaged to the extent of from one-fourth to one-half of the whole, by sudden frosts or freezes, of which our farmers had no warnings.

Some of the immediate benefits of the State Weather Service may only be briefly touched upon here.

1. It will bring the benefits of the weather "indications," "cold-wave" warnings, etc., of the United States Signal Office to bear directly upon the interests and daily lives of a

great many of our people, and secure for them whatever benefits there may be in them.

2. The weather service will be the means of securing a much better knowledge of the meteorology of our State, which will be valuable in more ways than can be named here.

3. It will give the people of all parts of the State reliable standards for temperature, rain-fall, humidity, wind-velocity, etc., which are sources of varied, useful information.

4. It will put within the reach of local agricultural clubs and individual farmers the means of accurate observations upon the relations of the weather to our crops. Without a weather record in figures, our conceptions of what the weather was during any particular season are sure to be very unreliable.

5. It will educate the people at large on the subjects in science which have the most important bearing upon their interests, comfort and lives.

The State Weather Service, as established and now in operation, is an organization of the voluntary observers and signal men throughout the State of North Carolina, co-operating with the United States Signal Service and this Experiment Station. The Signal Service stations an experienced observer at the central office, who acts as assistant to the Director of the State Service in keeping the records of the meteorological data, in preparing summaries of the state of the weather, in distributing to the Signal Stations the various weather indications.

Heretofore the Central Station has been located at the Experiment Farm, $1\frac{1}{2}$ miles from the city, but on account of the obvious difficulty in keeping the records at a point so distant from the office of the Director, the Station was removed to the city, where it now occupies a commodious office in the Agricultural Building. Here the records are kept, and all the work of compiling the data received from the various observers goes on. Connected with the office,

too, is a complete observing station, ranking first-class in all of its appointments. Self-recording instruments, maximum and minimum thermometers, anemometer, wet and dry bulb thermometer, are conveniently located on the summit of the roof. Two standard barometers are in use in the office, and a standard rain gauge is located in rear of the building at the surface of the ground. On the roof is a 36-foot flag-staff, upon which are displayed daily signal flags giving the weather indications. Tri-daily observations are taken at 7 A. M., 3 P. M., and 10 P. M., which are transmitted by telegraphic cipher to Washington, where they are used in the preparation of a daily weather map of the United States, and for other meteorological purposes.

The Central Weather Station in the past year has been able to procure from U. S. Signal Service in Washington daily telegraphic dispatches, giving the state of the weather, barometer reading, temperature, rainfall, &c., of thirty different stations, scattered throughout the United States, which are published in the daily city papers, and posted in several public places for the convenience of the people generally. These telegrams are used by the business men of the city and by the Cotton and Grocers' Exchange; at this latter building a large U. S. map is displayed, on which are posted daily colored symbols, showing the change of the weather at the various localities throughout the country. By this means the people of the city and the surrounding country can get reliable and valuable statistics, showing the state of the weather elsewhere, which will prove of great benefit to them in their several lines of business.

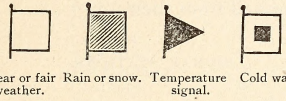
WEATHER SIGNALS.

The daily weather indications and "cold-wave" warnings sent out from the Signal Office at Washington are distributed to numerous signal stations in North Carolina. These reports are posted on bulletin-boards or displayed by flags

on considerable elevations, so that the signals may the better be distributed to the people generally. Below is given a copy of a signal card describing the various signal flags in use, issued by the State Service for the benefit of the public:

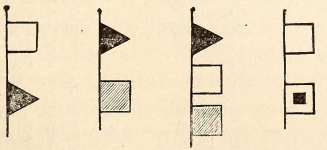
WEATHER SIGNALS IN USE JANUARY, 1888.

Hoisted at 8 o'clock A. M. daily (except Sunday), indicates the weather for the 24 hours following:



No. 1, white flag, 6 ft. square, clear or fair weather, no rain. No. 2, blue flag, 6 ft. square, rain or snow. No. 3, black triangular flag, 6 ft. at the base and 6 ft. in length, refers to temperature. When placed above Nos. 1 or 2, warmer weather; when placed below Nos. 1 or 2, colder weather; when not displayed, temperature stationary, or that the change in temperature will not vary five degrees of the same hour of the preceding day. No. 4, cold wave flag, 6 ft. square, the approach of a sudden and decided fall of temperature. This signal is usually ordered at least 24 hours in advance of the cold wave. It is not displayed unless a temperature of 45 degrees or less is expected, nor is flag No. 3 displayed with it. The orange rain flag in use formerly has been discontinued.

EXAMPLES—DISPLAYED FROM POLES.



The above set of four flags, made of standard bunting, can be purchased for $6 per set; or if preferred, they can be made of cotton cloth at a cost of not more than $3 per set.

The distribution of the telegrams of the weather indications was interrupted in April, 1887, owing to a decreased appropriation from the United States to the Signal Service, but was resumed on July 1st on a much more substantial basis. Under the reorganization, the number of stations displaying signal flags will be largely increased, so that a greater number of the people of the State can reap the advantage to be derived from them.

SIGNAL STATIONS.

Stations where flags or bulletins are used to circulate widely the weather indications and warnings, are termed Signal Stations. They now number 54, are scattered throughout the State, and are located in nearly every portion reached by telegraphic lines.

LIST OF SIGNAL STATIONS.

NAME OF STATION.	NAME OF COUNTY.	DISPLAYED BY
Asheville	Buncombe	Battery Park Obs.
Battleboro	Nash	A. J. Hobgood.
Burlington	Alamance	J. A. Turrentine.
Cameron	Moore	K. M. Ferguson.
Chapel Hill	Orange	R. E. Carr.
Cronly	Columbus	A. T. Wishart.
Durham	Durham	H. H. Snow.
Fayetteville	Cumberland	Rose & Leak.
Faison	Duplin	J. S. Westbrook.
Gibson Station	Richmond	W. H. Morrison.
Greensboro	Guilford	J. H. Hampton.
Gastonia	Gaston	J. T. Bingham.
Goldsboro	Wayne	Argus Publishing Co.
Henderson	Vance	J. L. Currin.
Hickory	Catawba	O. M. Royster.
High Point	Guilford	Chief of Police Hoffman.
Hot Springs	Madison	C. F. McGahan.
Jonesboro	Moore	M. C. McIver.

LIST OF SIGNAL STATIONS—CONTINUED.

NAME OF STATION.	NAME OF COUNTY.	DISPLAYED BY
King's Mountain	Cleveland	C. M. Nolan.
Kinston	Lenoir	R. F. Whitehurst.
Louisburg	Franklin	O. L. Ellis.
Leaksville	Rockingham	B. F. Ivey.
Lenoir	Caldwell	J. M. Bernhardt.
Lincolnton	Lincoln	Jenkins Bros.
Magnolia	Duplin	H. J. Hope.
Marion	McDowell	W. F. Craig.
Maxton	Robeson	S. W. Parkham.
Monroe	Union	T. M. Brown.
Mooresville	Iredell	A. Leazer.
New Berne	Craven	Prest. Washington Bryan
Newton	Catawba	E. P. Schrum.
Oxford	Granville	W. H. White.
Pineville	Mecklenburg	W. T. Young.
Pittsboro	Chatham	W. R. Hunter.
*Raleigh (Agr. Building)	Wake	H. McP. Baldwin.
" (City Hall)	"	Police Department.
" (Shaw Univ.)	"	Dr. H. M. Tupper.
Reidsville	Rockingham	Geo. R. Quincy.
Rockingham	Richmond	W. E. Shortridge.
Rocky Mount	Edgecombe	S. K. Fountain.
Salisbury	Rowan	Jno. H. Hedrick.
Shelby	Cleveland	J. E. Martin.
Smithfield	Johnston	J. Morris.
Statesville	Iredell	D. M. Conn.
Tarboro	Edgecombe	W. E. Fountain.
Toisnot	Wilson	C. F. Black.
Thomasville	Davidson	J. A. Elliott.
Warrenton	Warren	Arrington Bros.
Wake Forest	Wake	Prof. W. G. Simmons.
Warsaw	Duplin	J. W. Morrison.
Weldon	Halifax	H. S. Cooper.
Whitaker's	Edgecombe	J. C. Basswell.
Winston	Forsyth	Brown & Brown.
Walnut Cove	Stokes	J. A. Burton.

* Central Station.

OBSERVING STATIONS.

The important work of collecting meteorological statistics is carried on by the voluntary assistance of observers scattered pretty well throughout the State from east to west, with the additional information obtained from the reports of regular signal service observers located in this and the adjacent territory of other States.

The State Weather Service is entirely a voluntary organization, without any funds for the purchase of meteorological instruments. We find it very difficult, therefore, to extend the number of observing stations to include mountainous and other sections of the State where it would be desirable to have observations. Various friends and communities have assisted the service in the past by equipping many of the observing stations already established. But the State Service is greatly in need either of funds or of instruments with which to supply newly created observing stations.

Negotiations are now pending with the U. S. Signal Service whereby it is hoped that a supply of instruments can be procured on favorable terms, and the number of stations thus largely increased.

The full set of instruments for voluntary observers consists of maximum registering thermometer, minimum registering thermometer, dry bulb thermometer, wet bulb thermometer, and rain-gauge with overflow and measuring-stick. All the new instruments are of H. J. Green's best make, and were corrected at Washington. In addition, some of the stations are supplied with standard barometers.

OBSERVING STATIONS.

STATION.	COUNTY.	OBSERVER.
Asheville	Buncombe	Asa S. Loomis.
Chapel Hill	Orange	Prof. J. W. Gore.
Charlotte	Mecklenburg	*Jas. A. Barry.
Cape Henry, Va	Princess Anne	*William Davis.
Chattanooga, Tenn	Hamilton	*L. M. Pindell.
Davidson College	Mecklenburg	Prof. H. L. Smith.
Goldsboro	Wayne	John R. McMachen.
Hatteras	Dare	*Geo. H. Penrod.
Henderson	Vance	J. L. Curren.
Hot Springs	Madison	Dr. C. F. McGahan.
Kitty Hawk	Currituck	*P. H. Fitzmaurice.
Knoxville, Tenn	Knox	*Chas. F. Dickens.
Lenoir	Caldwell	Dr. R. L. Beall.
Lynchburg, Va	Campbell	*W. H. Fallon.
Marion	McDowell	W. F. Craig.

OBSERVING STATIONS—CONTINUED.

STATION.	COUNTY.	OBSERVER.
Maxton	Robeson	Dr. J. D. Croom.
Monroe	Union	D. C. Anderson.
Mt. Pleasant	Cabarrus	Prof. H. T. J. Ludwig.
New Berne	Craven	William Dunn.
Norfolk, Va	Norfolk	*Jas. P. Sherry.
Oxford	Granville	W. C. Biggs.
†Raleigh	Wake	*H. McP. Baldwin.
Reidsville	Rockingham	Prof. T. V. Norcom.
Salisbury	Rowan	John A. Hedrick.
Salem	Forsyth	Rev. John Clewell.
Southport	Brunswick	*E. E. Perry.
Tarboro	Edgecombe	E. V. Zoeller.
Wake Forest	Wake	Prof. W. G. Simmons.
Waynesville	Haywood	W. W. Stringfield.
Weldon	Halifax	T. A. Clark.
Wilmington	New Hanover	*F. P. Chaffee.

†Central Station.

*Signal Service Observers.

Monthly summaries of the above stations have been published in the BULLETIN of the Department of Agriculture during the past year. These reports will be continued monthly; and it is hoped, with the increased number of Observing Stations, that they will be of largely increased value

Weather Review of the North Carolina Weather Service.

GEOGRAPHICAL.

The meteorological conditions tabulated in this review relate chiefly to the climatic changes in the State of North Carolina and its adjacent territory in the States of Virginia and Tennessee.

North Carolina is included nearly between the parallels 34° and 36½° north latitude, and between the meridians 75½° and 84½° west longitude. The extreme length of the State from east to west is 503¼ miles, the extreme breadth is 187½ miles, and its area embraces 52,286 square miles. The general topography of the land is a vast declivity, sloping from the summits of the Smoky Range Mountains, an altitude of nearly 7,000 feet, (embracing the highest land in the United States east of the Rocky Mountains), to the level of the Atlantic Ocean on the east.

ANNUAL METEOROLOGICAL SUMMARY FOR NORTH CAROLINA FOR 1887.

Below is given a meteorological summary for the whole State for the year 1887, compiled from the reports of our observers:

ANNUAL METEOROLOGICAL SUMMARY FOR THE STATE OF NORTH CAROLINA FOR 1887.

Month.	Atmospheric Pressure.			Air Temperature (Degrees Fah.)								Rel. Humidity, (per cent. of.)			Precipitat'n in inches—rain, snow, sleet, hail.			Weather. (No. of Days.)				Wind.	
	Mean.	Normal.	Departure.	Mean.	Normal.	Departure.	Highest.	Date.	Lowest.	Date.	Monthly Range.	Mean.	Normal.	Departure.	Average for month.	Normal.	Departure.	Clear.	Fair.	Cloudy.	Rainy.	Prevailing direction.	Average direc. for many ye'rs
January	30.13	30.19	—.06	39.1	41.4	—2.3	73.0	23	—4.0	6	77.0	....	76.5	...	2.92	5.50	—2.58	10	14	7	9	S. W.	S. W.
February	30.24	30.19	+.05	49.2	45.0	+4.2	79.0	1	12.0	27	67 0	76.0	70.4	+5.6	3.85	4.45	—0.60	4	11	13	17	NE SW	S. W.
March	29 99	30.04	—.05	47.2	49.2	—2.0	84.0	2	11.0	28	73.0	65.4	66 2	—0.8	3.15	5 50	—2.35	13	9	9	8	N. W.	S. W.
April	30.05	30.00	+.05	57.1	57.5	—0.4	93.0	12	24.0	6	69.0	64.6	66.3	—1.7	2.87	4.51	—1.64	14	10	6	9	W.	S. W.
May	30.01	30.03	—.02	69.9	66.9	+3.0	95.0	18	32.0	6	63.0	73.9	69.4	+4.5	4.55	3 76	+0.79	11	14	6	11	S. W.	S. W.
June	30.01	30.01	.00	73.8	74.6	—0.8	102.0	20	43.0	13	59.0	70.6	72.4	—1.8	4.24	4.41	—0.17	12	12	6	9	N. E.	S. W.
July	30.09	30.02	—.02	78.8	78.5	+0.3	107.1	18	56.0	1	51.1	77.9	69.7	+8.2	5.57	5.16	+0.41	8	13	10	13	S. W.	S. W.
August	29.98	30.04	—.06	75.4	76.5	—1.1	99.8	12	46.0	31	53.8	80.9	74.5	+6.4	8.85	5.61	+3.24	10	14	7	14	N. E.	N. E.
September	30.09	30.08	+.01	69.3	70.0	—0.7	101.0	14	33.0	25	68.0	74.2	74.4	—0.2	2.29	4.33	—2.04	11	13	6	6	S. W.	N. E.
October	30.05	30.14	—.09	58.4	60.8	—2.4	92.0	10	47.0	31	45.0	74.5	74.5	0.0	5.24	3.83	+1.41	14	6	11	11	N. E.	N. E.
November	30.12	30.20	—.08	48.2	49.7	—1.5	77.0	4	12.0	21	65.0	70.4	70.6	—0.2	1.09	4.09	—3.00	14	10	6	5	S. W.	N. E.
December	30.12	30.17	—.05	42.6	41.6	+1.0	68.0	4	12.9	30	45.1	77.6	73.6	+4.0	4.75	4.85	—0.10	6	12	13	13	N. E.	S. W.
An'l Means.	30.07	30.09	—.02	59.1	59.3	—0.2	....	.	....	..	61.3	73.3	71.5	+1.8	49.37	56.00	—6.63	127	138	100	125	S. W.	S. W.

EXPLANATION OF THE ABOVE TABLE.—To show more explicitly the meaning of the above table, the following explanation is given: The mean monthly atmospheric pressure is obtained by dividing the sum of the average pressure at 7 A. M., 3 P. M. and 10 P. M., by 3, viz:

Average atmospheric pressure at	7 A. M.		30.16 inches.
" " "	3 P. M.		30.09 "
" " "	10 P. M.		30.14 "
Sum		3	90.39 "
Mean monthly			30.13 "

The mean annual pressure is obtained by taking the sum of the mean pressure for each month and dividing by 12.

The normal monthly pressure is obtained by taking the sum of the mean monthly pressure for many years and dividing by the number of years taken.

The normals for this State have been obtained from the records of 7 Signal Service Stations from January, 1880, to December, 1884, inclusive.

The monthly mean temperature is obtained by dividing the sum of 7 A. M., 3 P. M. and 10 P. M. averages by 3, from regular Signal Service Stations, and by dividing the sum of 7 A. M., 2 P. M., and twice the 9 P. M. averages by 4, from voluntary stations.

The mean rel. humidity is obtained by dividing the sum of the averages of the 7 A. M., 3 P. M. and 10 P. M. (in case of Signal Service Stations), and the 7 A. M., 2 P. M. and 9 P. M. (in case of Voluntary Stations) by 3. The normal rel. humidity and normal precipitation are obtained in the same way as for pressure.

The state of the weather is determined at each observation by the amount of clouds observed. 0 represents a clear sky, entirely free from clouds. 10 represents the whole sky covered with clouds, and 1, 2, 3, 4, 5, 6, 7, 8, 9, the different degrees of cloudiness which lie between.

A *clear* day is one on which from 0–8 tenths clouds have been observed, viz: 7 A. M., 2 tenths; 3 P. M., 4 tenths; 10 P. M., 2 tenths; total, 8 tenths, or a clear day. A *fair* day is one on which from 9–22 tenths have been observed. A *cloudy* day is one on which 23–30 tenths have been observed. A *rainy* day is one on which .01 inch of precipitation (including rain, snow, sleet, hail), fell. A rainy day may be either a clear, fair, or cloudy day. The sum of the clear, fair and cloudy days will of course make up the total number of days of the month, or of the year.

METOROLOGICAL NOTES NOT INCLUDED IN TABLE.—The highest temperature during the year, 107.1 degrees, occurred on July 18th, at Kitty Hawk,this being the highest on record.

The lowest temperature, 4 degrees below zero, occurred at Salem on January 6th, which is 12 degrees higher than the lowest on record, which occurred in 1884 at Knoxville, Tenn.

The last killing frost of the winter of '86 and '87, occurred on May 6th, 1887. The first killing frost of the winter of '87 and '88, occurred September 25th, 1887. The last snow of the winter of '86–'87, occurred April 2d.

The first snow of the winter of '87–'88, occurred October 30th.

For further detailed notes, reference must be made to the monthly summaries.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JANUARY, 1887.

Atmospheric Pressure.—Our barometer stations are so limited in number that our notes and remarks upon this subject must necessarily be brief. Mean pressure for the State: 30.127 inches, deduced from barometric readings at nine different points. The highest, 30.642, on the 4th, was recorded at Raleigh, Wake county; the lowest, 29.487, on the 17th, at Norfolk, (Va)., Norfolk county. The absolute range was 1.155 inches, and the greatest range at one place, 1.078 inches, at Knoxville, (Tenn)., Knox county.

Temperature.—Mean temperature of the State was 39°1. The characteristic features of the first ten days were decidedly cold; the lowest temperature for the month at many points occurred during this period, especially at Salem, Forsyth county, where the minimum, 4° below zero, was recorded on the 6th. This can be regarded as the "lowest" in the State during the month, but it was not, however, the "coldest day," which occurred on the 3d, when a mean of 17° for all points was recorded. The minimum at Asheville, on this date, stood at 2°, and at Salem 4°. Minimum temperatures for the State ranged from 4° below zero at Salem, to 15° above zero at Wilmington.

With exception of a second "cold snap," 18th to 19th, inclusive, the temperatures were generally normal, or abnormally high, and continued so to the end of the month. The warmest day, a mean of 61° for all points, occurred on the 23d, when most of the State observers recorded their maximum temperature. The warmest day was the 23d, when the observers at Kinston, Tarboro, Goldsboro, and Wilmington obtained records of 73°. The maximum temperatures ranged from 64° at Smithville to 73° at various other points already named. The 21st, 22d and 23d were exceptionally warm days, and exceeded any others dating from the 10th to the 17th inclusive, and 20th to the 31st inclusive, when warm weather prevailed.

The three warmest days were veritable "storm breeders," for an atmospheric disturbance of unusual severity, accompanied by copious rains, high winds, and low temperatures, traversed the State on the 24th, from west to east, with remarkable rapidity. No serious damage was done until it reached the eastern portion of the State, when it augmented in fury, threw down fences, upset chimneys, and demolished a number of small houses. The force of the wind, after the storm had reached the coast, must have been terrific, for the only available data at hand shows a registered maximum velocity of fifty miles an hour, from the northwest, at Cape Henry, Va. The rainfall at Lenoir was 2.50 inches.

Precipitation.—The average precipitation of the State for the month was 2.92 inches. Heavy rainfalls (one inch or more) are reported at Cape Henry (Va.), 1.00 inches, and Norfolk (Va.), 1.68 inches on the 5th. At Knoxville (Tenn.), 1.76 inches on the 23d; at Lynchburg (Va.), 1.31 inches, and at Lenoir, 2.50 inches on the 24th; at Asheville, 1.26 inches on the 29th; at Lenoir, 1.00 inch on the 29th, and a most extraordinary rainfall of 3.48 inches at Chattanooga (Tenn.), on the 23d; this was the severe storm that passed through North Carolina on the 24th. Precipitation was generally distributed throughout the month, and most points in the

State were favored with a fair average rainfall. The heaviest rains (or snow) fell on the 1st, 5th, 13th, 14th, 17th, 23d, 24th, 29th and 30th. There were eight days during the month noted for an entire absence of rain. Sleet storms prevailed at Raleigh and Reidsville on the 1st; at Weldon on the 5th; at Mt. Pleasant on the 6th; at Raleigh on the 10th; at Tarboro on the 26th.

Character of Weather.—For the State, average number of days clear, 10; fair, 14; cloudy, 7; on which appreciable precipitation fell, 9.

Wind.—The prevailing direction for the State was southwest. At Smithville and Tarboro the prevailing winds were "north." The highest velocity of wind and direction are reported as follows: Cape Henry (Va.), 50 miles per hour, N. W., on 24th. Total movement during month, 12,173 miles; average velocity, 16 miles per hour. Lynchburg (Va.), 25 miles per hour, N. W., on 17th; average velocity, 4 miles per hour; total movement during month, 3,036 miles. Norfolk (Va.), 26 miles per hour, S. W., on 20th. Wilmington, 34 miles per hour, N. W., on 24th; average velocity, 8 miles per hour; total movement during month, 6,164 miles. Charlotte, 24 miles per hour, N. W., on 24th; average velocity, 5 miles per hour; total movement during month, 3,480 miles. Raleigh, 36 miles per hour, N. W., on 24th. Knoxville (Tenn.), 40 miles per hour, S. W.; average hourly velocity, 8 miles per hour; total movement during month, 6,047 miles. Chattanooga (Tenn.), 33 miles per hour, W.; average velocity, 8 miles per hour; total movement during month, 5,964 miles.

Thunder Storms.—Hamilton county, Chattanooga, Tenn., 13th. Knox county, Knoxville, Tenn., 23d and 24th. Buncombe county, Asheville, N. C., 23d. Wayne county, Goldsboro, N. C., 29th. Caldwell county, Lenoir, N. C., 23d.

Solar Halos.—Knox county, Knoxville, Tenn., 4th. Hamilton county, Chattanooga, Tenn., 4th and 6th.

Lunar Halos.—Cabarrus county, Mount Pleasant, 9th.

Caldwell county, Lenoir, 7th. Forsyth county, Salem, 6th. Halifax county, Weldon, 6th. Hamilton county, Chattanooga, Tenn., 4th. Knox county, Knoxville, Tenn., 4th and 6th. Mecklenburg county, Charlotte, 2d, 4th, 6th, 8th. Rockingham county, Reidsville, 4th, 6th. Wake county, Raleigh, 6th, 8th. Wayne county, Goldsboro, 4th, 7th, 25th.

Meteors.—Cabarrus county, Mt. Pleasant, 27th.

Frosts.—Frosts were generally noted during the early and later portion of the month.

Fogs.—Cabarrus county, Mount Pleasant, 14th. Forsyth county, Salem, 10th, 14th, 29th. Wake county, Raleigh, 6th, 22d.

Red Sunsets.—Forsyth county, Salem, 2d, 3d, 15th, 19th, 20th, 24th. Wake county, Raleigh, 11th, 15th, 20th, 21st, 24th, 25th, 26th, 27th, 30th, 31st.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, FEBRUARY, 1887.

General Summary for the State.—Mean barometer, 30,236 inches. Highest barometer, 30,853 inches on 5th, at Chapel Hill. Lowest barometer, 29,496 inches on 11th, at Lynchburg, Va. Absolute range of barometer, 1,357 inches. Mean temperature, 49.2 degrees. Highest temperature, 79° on 1st at Chapel Hill. Lowest temperature, 12° on 27th, at Asheville. Greatest daily range 39° on 1st, at Knoxville, Tenn. Least daily range, 3° on 19th, at Smithville. Mean daily range of temperature, 18.9°. Mean relative humidity, 76 per cent. Average monthly rainfall, 3.85 inches. Prevailing direction of wind, N. E. and S. W. Average number of clear days, 4. Average number of fair days, 11. Average number of cloudy days, 13.

Thunder Storms.—At Knoxville, on the 1st and 2d; at Chattanooga, on the 23d; at Knoxville and Chattanooga, on the 24th; at Chattanooga, on the 26th; at Waynesville,

on the 27th; at Kitty Hawk, on the 27th; at Weldon, on the 18th, 26th (lightning only); at Tarboro, on the 18th (lightning only); Charlotte, Davidson College, and M. Pleasant, on the 26th; Goldsboro on the 18th; and Raleigh on the 1st.

Frosts.—Heavy frosts on the 6th, 10th, at Lynchburg (Va.); on the 12th, at Lynchburg and Norfolk (Va.); on the 13th, at Kitty Hawk, Weldon, Cape Henry (Va.), Wilmington, Lynchburg (Va.), Tarboro, Norfolk (Va.), and New Bern; on the 14th, at Weldon, Smithville, Cape Henry (Va.), Wilmington, Lynchburg (Va.), Tarboro, Norfolk (Va.), and New Berne; on the 15th, at Lynchburg (Va.); on the 27th at Lynchburg (Va.), and New Berne; on the 28th, at Kitty Hawk, Weldon, Smithville, Cape Henry (Va.), Wilmington, Lynchburg (Va.), Tarboro, Norfolk (Va.), and New Berne; at Raleigh and Chapel Hill on the 5th; at High Point and Chapel Hill on the 6th; at Reidsville, High Point, Chapel Hill and Charlotte on the 12th; at Raleigh, Reidsville, Chapel Hill, Mt. Pleasant, Davidson College, Wake Forest, Kinston, Goldsboro, Charlotte and Salem on the 13th and 14th; at Reidsville, High Point, Chapel Hill, Mt. Pleasant, Davidson College and Charlotte on the 15th; at High Point on the 16th; at Reidsville, Mount Pleasant, Salem and Goldsboro on the 17th; at High Point on the 18th; at Reidsville and Salem on the 19th; at Reidsville on the 21st; at Reidsville, High Point, Mount Pleasant, Salem and Charlotte on the 25th; at Reidsville, High Point and Charlotte on the 27th; at Raleigh, Reidsville, High Point, Chapel Hill, Maxton, Mount Pleasant, Davidson College, Wake Forest, Kinston, Goldsboro and Charlotte on the 28th; at Chattanooga, (Tenn.), on the 12th, 13th, 27th and 28th; at Knoxville, (Tenn.), on the 12th, 13th, 25th, 27th and 28th; at Waynesville on the 5th, 12th, 13th, 14th, 17th, 19th, 25th and 28th; at Marion on the 6th, 7th, 9th, 10th, 11th, 12th, 13th, 18th, 25th and 28th; at Asheville on the 1st, 4th, 6th, 12th, 13th, 14th, 27th and 28th.

Fogs.—Wilmington on the 1st, 2d, 3d, 7th, 8th and 10th; at Tarboro on the 2d, 3d, 6th, 7th, 15th and 16th; at Smithville on the 1st, 2d and 3d; at Norfolk (Va.), on the 8th; at Raleigh on the 2d, 3d, 6th, 7th, 8th, 15th, 16th and 20th; at Salem on the 2d, 3d and 16th; at Davidson College on the 3d, 7th and 16th; at Chapel Hill on the 2d, 3d and 16th; at Reidsville on the 7th and 16th; at Marion on the 2d and 3d.

Dew.—Cape Hatteras on the 1st, 8th and 17th.

Sleet.—Weldon on the 15th, and Tarboro on the 4th.

Lunar Halos.—At Knoxville, (Tenn.), on the 6th and 7th.

Solar Halos.—At Chattanooga, (Tenn.), on the 13th and 19th; noted at Maxton on the 14th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, MARCH, 1887.

General Remarks.—That popular and proverbial maxim relating to the month of March, "enter as a lamb, exit as a lion," was practically illustrated this year. The month opened balmy and spring-like, with warm genial sunshine, high temperatures (the maximum at nearly all stations was noted on the second day), clear skies, and a general absence of rain; peach-trees began to bud and leaf, fresh grass appeared.

On the other hand, four of the final days were remarkable for strong winds, hoar frosts, heavy rains, snow and sleet, with decidedly freezing weather at all points; the temperatures were generally reduced to ten and fifteen degrees below freezing, and in the mountainous district even twenty-one degrees below freezing was recorded. It was during this period (on the 30th) that most of the observers noted their minimum temperature for the month.

The severity of this change, and its general slope was, unfortunately, largely destructive to plant life; however,

rain set in, which caused it to disappear very rapidly. There was much damage to fruit, early vegetables, oats and clover, and we learn in some localities that tobacco plants have been killed or seriously injured.

The "cold snap" of the last of March was very destructive in its results, and wide-spread. The approaching frost was duly announced by the U. S. Signal Service.

At many points the highest barometric readings, and the least daily range of temperature were recorded, simultaneously, on the 5th.

Temperature.—The monthly mean temperature, 47.2 degrees, compared with the same authoritative records, was two degrees colder than the normal computed from observations covering a series of seven to seventeen consecutive years.

The highest temperature, 83° on the 2d, at Chapel Hill, is 1° less than the highest (84° at Wilmington in 1878) on record. The lowest temperature, 11° on the 28th, at Asheville, is 5° in excess of the lowest (6° at Knoxville, Tenn., in 1878) on record. The greatest daily range, 48° on the 2d, was recorded at Maxton. The least daily range, 2.6° on the 5th, was recorded at Raleigh. The mean daily range of temperature, 21.°6 was 5.°8 in excess of the normal mean (15.°8), deduced from the Signal Service records.

Wind and Weather.—The prevailing direction of wind N. W. The average number of clear days, 13, was an excess of 3 as compared with the average for a number of years. The average number of fair days, 9, was 2 less than the average computed for a number of years. The average number of cloudy days, 9, was 1 less than the average computed for a number of years. The average number of rainy days was 8.

Precipitation.—The mean relative humidity was 66.1 per cent. The distribution of rain, snow and sleet can be divided into four distinct periods, 41 per cent. from the 4th to the 10th inclusive, 12 per cent. from the 21st to the 22d inclu-

sive, 28 per cent. from the 27th to the 29th inclusive, 19 per cent. on the 31st.

The heavy and continuous rains, in connection with the abnormally high temperature during the first period, as demonstrated by these figures, plainly show the favorable conditions under which vegetation obtained an early start.

The average monthly rainfall, 3.15 inches, as compared with the official records at eleven stations of the U. S. Signal Service, within and adjacent to the State, show a deficiency of 2.35 inches.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, APRIL, 1887.

Pressure.—Mean for April, 1887, 30.05 inches; normal mean for April, 30.00 inches; deviation from the normal + 0.05 inches; highest, 30 65 inches at Chapel Hill on the 8th; lowest, 29.35 inches at Lynchburg, (Va.), on the 18th; absolute range, 1.30 inches.

Temperature.—Mean for April, 1887, 57.1°; normal mean for April, 57.5°; deviation from the normal, —0.4°; highest, 93° at Maxton, on the 12th; lowest, 24° at Marion, on the 6th; morning average, 48.4°; afternoon, 67.8°; night, 55.9°; mean of maximum, 86.3°; mean of minimum, 30.1°; greatest daily range, 52.0° at Maxton, on 11th; lowest daily range, 2.1° at Raleigh, on 1st; greatest monthly range, 65.0° at Davidson College, Marion and Maxton; least monthly range, 38.9° at Hatteras; mean monthly range, 55.8° at Hatteras; absolute range, 69.0° at Hatteras; warmest day, 11° above normal on 12th; warmest locality at Maxton; coldest day 20° below normal, on 1st; coldest locality at Weldon; normal readings 11 per cent.; abnormally high, 47 per cent.; abnormally low, 42 per cent.

Relative Humidity.—Mean for April, 1887, 64.6 per cent.; normal mean for April, 66.3 per cent.; greatest monthly

mean, 83.6 per cent. at Goldsboro; least monthly mean, 49.7 per cent. at Chattanooga.

Precipitation.—Average for April, 1887, 2.87 inches; normal average for April, 4.51 inches; deviation from the normal, 1 39 inches deficiency; daily average, 0.10 inches; greatest monthly rainfall, 4.64 inches at Maxton; greatest local daily rainfall, 2.80 inches at Lenoir on 22d; heavy rainfalls (exceeding one inch), on the 1st at Hatteras and Wilmington; on the 22d at Salem, Lenoir, Knoxville and Chattanooga; on the 23d at Marion and Knoxville; on the 25th at Raleigh, Maxton, Chapel Hill, Salem and Reidsville.

Winds.—Prevailing direction, westerly; highest velocity, 47 miles per hour, W. on 28th at Hatteras; highest average hourly velocity, 16.2 miles at Hatteras.

Weather.—Average number of clear days for April, 1887, 14.2 days; average number of clear days for many Aprils, 9.4 days; April, 1887, compared with average for many years, 4 8 excess; average number of fair days for April, 1887, 9.9 days; average number of fair days for many Aprils, 11.9 days; April, 1887, compared with averages for many years, 2.0 deficiency; average number of cloudy days for April, 1887, 5.8 days; average number of cloudy days for many Aprils, 8.7 days; April, 1887, compared with average for many years, 2.9 deficiency; average number of rainy days for April, 1887, 8.6 days.

Drought.—The first thirteen days of the month were remarkable for a general absence of rain, followed by a series of thunder storms, commencing on the 15th, and generally distributed throughout the State and adjacent territory. These storms continued at intervals of three and four days apart to the end of the month, and at many points hail, remarkable for size and quantity, fell. Except at Tarboro, where a few houses were damaged by wind and lightning, no serious casualties can be traced to these storms.

The following extract is furnished by Mr. E. V. Zoeller, observer at Tarboro.:

"On night of 15th and 16th heavy thunder storm, light and heavy rains, with hail, vivid lightning, destructive in a southeasterly direction from here. Barn and implement shed of Ed. E. Knight, about six miles from here, was struck and burned to the ground. A number of forest trees in same neighborhood are reported to have been stricken One was ignited. The casualty occurred between 12 and 1 o'clock."

Miscellaneous Phenomena.—Thunder storms on the 14th, 15th, 16th, 18th, 20th, 22d, 23d, 24th, 27th, 28th. Frosts on the 1st, 2d, 3d, 4th, 5th, 6th, 7th. 9th, 10th, 14th, 20th, 21st, 26th. Fogs on the 7th, 13th, 14th, 15th, 21st, 26th. Dews on the 10th, 12th, 13th, 14th, 16th, 17th, 21st, 24th, 26th, 27th, 28th, 30th. Sleet on the 1st. Hail on the 1st, 15th, 16th, 18th, 20th, 25th, 28th. Snow on the 1st, 2d. Haze on the 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 16th, 17th, 23d, 27th, 30th. Solar halos on the 5th, 7th, 14th, 28th. Lunar halos on the 4th, 6th, 30th. Droughts on the 1st to 16th, inclusive. Meteors on the 15th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, MAY, 1887.

Atmospheric Pressure.—Mean for May, 1887, 30.01 inches; normal for May, 30.03 inches; deviation from the normal, + .02 inches; highest, 30.42 inches at Chapel Hill, on the 15th; lowest, 29.53 inches at Hatteras, on the 27th.

Temperature.—Mean for May, 1887, 69.9°; normal for May, 66.9°; deviation from the normal, + 3.0°; highest, 95 0° at Maxton on the 18th; lowest 32.0° at Salem, on the 6th; highest on record for May, 98.0° at Norfolk in 1880; lowest on record for May, 37.0° at Lynchburg in 1876; average morning temperature, 63.6°; normal morning temperature, 63.6°: deviation from the normal,

0.0°; average afternoon temperature, 78.8°; normal afternoon temperature, 73.3°; deviation from the normal, + 5.5°; average night temperature, 67.6°; normal night temperature, 64.5°; deviation from the normal, + 3.1°; mean of maximum, 89.1°; normal mean of maximum, 93.2°; deviation from the normal, — 4.1°; mean of minimum, 47.6°; normal mean of minimum, 40.2°; deviation from the normal, + 7.4°; greatest daily range, 46.0° at Maxton on 2d; least daily range, 4.3° at Raleigh on 31st; mean daily range, 20.5°; greatest monthly range, 59.5° at Salem; least monthly range, 22.9° at Hatteras; mean monthly range, 41.4°; absolute range, 63.0°; warmest days, 8.0° above normal, on the 4th and 18th; coldest day, 5.0° below normal on the 15th; warmest localities, 3.0° above normal at Lynchburg, Maxton, Chapel Hill, and Knoxville, Tenn.; coldest locality, 2.0° below normal at Reidsville; normal readings, 9.1 per cent.; abnormally high readings, 70.5 per cent.; abnormally low readings, 20.4 per cent.

Precipitation.—Average for May, 1887, 4.55 inches; normal for May, 3.76 inches; deviation from the normal, + 0.79 inches; daily average, 0.15 inches; greatest monthly rain fall, 8.07 inches at Weldon; greatest local daily rainfall, 6.03 inches at Weldon on the 10th; heavy rainfalls (exceeding one inch), on the 6th at Maxton, Salem and Marion; on the 8th at Kitty Hawk and Goldsboro; on the 10th at Lynchburg, Va., Weldon and Chapel Hill; on the 11th at Tarboro; on the 20th at Mount Pleasant; on the 22d at Chattanooga, Tenn.; on the 23d at Wilmington, Smithville, Chapel Hill; on the 24th at Reidsville; on the 25th at Cape Henry, Va., and Knoxville, Tenn.; on the 30th at Lenoir and Chattanooga, Tenn.; on the 31st at Chapel Hill, Marion, Knoxville and Chattanooga, Tenn.

Relative Humidity.—Mean for May, 1887, 73.9 per cent.; normal for May, 69.4 per cent.; deviation from the normal, + 4.5 per cent.; greatest monthly mean, 88.4 per cent. at

Maxton; least monthly mean, 66.7 per cent. at Chattanooga, Tenn.

Winds.—Prevailing direction, southwesterly; highest velocity, 43 miles per hour from the west, on the 27th at Hatteras.

Weather.—Average number of clear days for May, 1887, 10.8; average number of fair days for May, 13.6; average number of cloudy days for May, 6.6; average number of clear days for many Mays, 11.4; average number of fair days for many Mays, 12.9; average number of cloudy days for many Mays, 6.6; clear days, deviation from the normal, — 0.6; fair, deviation from the normal, + 0.7; cloudy, deviation from the normal, 0.0; average number of rainy days for May, 1887, 10.8.

Droughts.—Of short duration prevailed from the 12th to the 22d.

Thunder Storms—Were generally distributed, and in several instances accompanied by hail. With exception of the 1st to 5th inclusive, 14th to 18th inclusive, and 27th to 29th inclusive, each day of the month was marked by these storms, and those on the 6th, 8th, 10th, 20th and 25th were remarkable for heavy rains and hail.

Miscellaneous Phenomena.—Thunder storms on the 6th, 7th, 8th, 9th, 10th, 11th, 12th, 13th, 19th, 20th, 21st, 22d, 23d, 24th, 25th, 26th, 30th, 31st; frost on the 6th; fogs on the 8th, 9th, 11th, 12th, 20th, 24th, 25th; dews on the 1st, 2d, 3d, 4th, 5th, 6th, 10th, 11th, 12th, 15th, 16th, 22d, 27th, 28th, 29th, 30th; hail on the 6th, 8th, 10th, 20th, 30th; haze on the 1st, 2d, 3d, 4th, 5th, 13th, 14th, 15th, 16th, 17th, 18th, 20th, 21st; meteors on the 26th; parhelia on the 30th; rainbows on the 7th, 24th. 26th; aurora on the 25th; solar halos on the 2d, 9th, 13th; solar corona on the 2d, 5th, 29th; lunar halos on the 1st, 2d, 3d, 4th, 5th; lunar corona on the 2d, 3d, 4th, 5th, 28th; lightning (distant) on the 6th, 7th, 8th, 9th, 10th, 12th, 13th, 22d, 25th, 26th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JUNE, 1887.

Atmospheric Pressure.—Mean for June, 1887, 30.01 inches; normal for June, 30.01 inches; departure from the normal, .00 inches; highest, 30.34 inches at Raleigh on the 29th; lowest, 29.63 inches at Norfolk, Va., on the 18th.

Air Temperature.—Mean for June, 1887, 73.8°; normal for June, 74.6°; departure from the normal, 0.8°; highest, 102.0° on the 20th at Mt. Pleasant; lowest, 43.0° on the 13th at Marion; absolute range, 59.0°; mean daily range, 21.4°; highest on record, 102.0°, occurred in 1874 at Norfolk, Va., and in 1887 at Mt. Pleasant; lowest on record, 43.0°, occurred in 1887 at Marion, as far as known; greatest daily range, 37.0°; least daily range, 6.6°; warmest day, 27.5° above the normal on the 20th; coldest day, 31.5° below the normal on the 13th.

Precipitation.—Average for June, 1887, 4.24 inches; normal for June, 4.41 inches; departure from the normal, 0.17 inches; daily average, 0.14 inches; greatest monthly rain fall, 9.74 inches at Southport; least monthly rainfall, 2.18 inches at Chattanooga, Tenn.; greatest local daily rainfall, 2.87 inches at Raleigh, on the 23d; daily rainfalls (exceeding one inch), Raleigh, 2.87; Charlotte, 1.60; Wilmington, 1.78; Norfolk, Va., 1.12; Cape Henry, Va., 1.61; Knoxville, Tenn., 1.46; Southport, 2.06; Davidson College, 1.45; Salisbury, 1.70; Weldon, 2.07; Marion, 1.10; Mt. Pleasant, 1.43; Lenoir, 2.40.

Relative Humidity.—Mean for June, 1887, 70.6 per cent; normal for June, 72.4 per cent; departure from the normal, 1.8 per cent; greatest monthly mean, 75.2 per cent. at Tarboro; least monthly mean, 65.2 per cent. at Davidson College.

Winds.—Prevailing direction for June, 1887, N. E.; average direction for June, S. W.; highest velocity, 30 miles from the southwest on the 1st at Chattanooga, Tenn.

Weather.—Average number of clear days, 11.7; average number of fair days, 12.1; average number of cloudy days, 6.2; average number of clear days, 9.1.

Droughts.—Longest duration of: At Lenoir, from 7 to 19, inclusive, 13 days; at Reidsville, from 11 to 17, inclusive, 9 days; at Tarboro, from 12 to 21, inclusive, 10 days; at Marion, from 12 to 20, inclusive, 9 days; at Davidson College, from 11 to 20, inclusive, 10 days; at Salisbury, from 11 to 19, inclusive, 9 days; at Mt. Pleasant, from 12 to 19, inclusive, 8 days; at Charlotte, from 24 to 30, inclusive, 7 days; at Southport, from 12 to 21, inclusive, 10 days; at Wilmington, from 12 to 21, inclusive, 10 days; at Raleigh, from 12 to 19, inclusive, 8 days; at Weldon, from 24 to 30, inclusive, 7 days; at Lynchburg, Va., from 12 to 19, inclusive, 8 days; at Norfolk, Va., from 24 to 30, inclusive, 7 days; at Cape Henry, Va., from 24 to 30, inclusive, 7 days; at Chattanooga, Tenn., from 12 to 20 inclusive, 9 days; at Knoxville, Tenn., from 9 to 20, inclusive, 12 days; average number of days (longest duration of) 9.

Thunder Storms.—Thunder storms occurred on the following dates: 1st, 2d, 3d, 4th, 6th, 7th, 8th, 9th, 10th, 17th, 18th, 20th, 21st, 22d, 23d, 25th.

Miscellaneous Phenomena.—Lunar halos, 2d, 3d, 4th, 5th, 6th, 26th, 27th, 30th; solar halos, 4th, 7th, 10th; frost, 12th, 13th (light); hail, 6th, 21st; fog, 16th, 24th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JULY, 1887.

Air Pressure.—Mean for July, 1887, 30.00 inches; normal for July, 30.02 inches; departure from the normal, —.02 inches; highest, 30.26 inches at Raleigh, on the 1st;

lowest, 29.72 inches at Norfolk, Va., on the 9th; range for the State, 0.54 inches.

Air Temperature.—Mean for July, 1887, 78.8°; normal for July, 78.5°; departure from the normal, + 0.3°; highest observed, 107.1° at Kitty Hawk, on the 18th; lowest observed, 56.0° at Marion, on the 1st; range for the State, 51.1°; highest on record, 107.1°, occurred in 1887 at Kitty Hawk; lowest on record, 53.0°, occurred in 1882 at Knoxville, Tenn.; mean monthly range, 34 8°; greatest monthly range, 44.0° at Marion; least monthly range, 21.0° at Asheville; mean daily range, 16.9°; greatest daily range, 33.9° at Charlotte, on the 19th; least daily range, 4.0° at Asheville, on the 3d; greatest mean daily range, 22.1° at Marion; least mean daily range, 10.1° at Asheville; mean of the maximum, 87.9°; mean of the minimum, 70.9°; warmest day, 28.3° above the normal; coldest day, 22.8° below the normal; average number of days maximum temperature was above 90°, 10.5.

Precipitation.—Average for July, 1887, 5.57 inches; normal for July, 1887, 5.16 inches; departure from the normal, + 0.41 inches; greatest monthly rainfall, 8.44 inches at Marion; least monthly rainfall at Asheville; greatest local daily rainfall, 4 00 inches at Southport, on the 4th; daily rainfalls (exceeding one inch): Wilmington, 2.88; Charlotte, 1.80; Raleigh, 1.88; Southport, 4.00; Kitty Hawk, 1.03; Weldon, 3.31; Salisbury, 3.00; Reidsville, 2.30; Marion, 1.52; Wake Forest, 1.51; Mt. Pleasant, 1.01; Monroe, 2.37; Lenoir, 2.80; Lynchburg, Va., 1.75; Norfolk, Va., 1.13; Chattanooga, Tenn., 1.28.

Relative Humidity.—Mean for July, 1887, 77.9 per cent.; normal for July, 69.7 per cent.; departure from the normal, + 8.2 per cent.; greatest monthly mean, 81.8 per cent. at Wilmington; least monthly mean, 70.7 per cent. at Marion.

Winds.—Prevailing direction for July, 1887, S. W.; average direction for July, 1887, S. W.; highest velocity, 36 miles from the North on the 18th, at Knoxville, Tenn.

Weather.—Average number of clear days, 7.9; average number of fair days, 13.4; average number of cloudy days, 9.7; average number of rainy days, 13.1.

Droughts.—Longest duration of: At Charlotte, from 9 to 18, inclusive, 10 days; at Raleigh, from 9 to 18, inclusive, 10 days; at Wilmington, from 10 to 13, inclusive, 4 days; at Wake Forest, from 10 to 18, inclusive, 9 days; at Mount Pleasant, from 10 to 18, inclusive, 9 days; at Weldon, from 10 to 18, inclusive, 9 days; at Salisbury, from 9 to 18, inclusive, 10 days; at Kitty Hawk, from 8 to 18, inclusive, 11 days; at Southport, from 8 to 21, inclusive, 14 days; at Reidsville, from 10 to 17, inclusive, 8 days; at Marion, from 8 to 14, inclusive, 7 days; at Norfolk, Va., from 10 to 20, inclusive, 11 days; at Lynchburg, Va., from 10 to 16, inclusive, 7 days; at Chattanooga, Tenn., from 9 to 11, inclusive, 3 days; at Knoxville, Tenn., from 9 to 17, inclusive, 6 days; average number days (longest duration of) 8.8.

Thunder Storms.—Thunder storms occurred on the following dates: 2d, 3d, 4th, 5th, 6th, 8th, 9th, 11th, 12th, 14th, 15th, 17th, 18th, 19th, 20th, 21st, 22d, 23d. 24th, 25th, 26th, 27th, 28th, 29th, 30th, 31st.

Miscellaneous Phenomena.—Lunar halos observed at Raleigh and Weldon, on the 1st, and at Mount Pleasant, on the 27th; solar halo observed at Chattanooga, Tenn., on the 26th; rainbows observed at Reidsville, on the 5th and 26th; fog at Chattanooga, Tenn., on the 7th, 13th, 21st, 22d, 26th, 27th, and at Raleigh, on the 30th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, AUGUST, 1887.

Air Pressure.—Mean for August, 1887, 29.98 inches; normal for August, 30.04 inches; departure from the normal, —.06 inches; highest, 30.27 inches, occurred at Wilmington,

on the 31st; lowest, 29.14 inches, occurred at Hatteras, on the 20th; range for the State, 1.13 inches.

Air Temperature.—Mean for August, 1887, 75.4°; normal for August, 76.5°; departure from the normal, —1.1°; highest observed, 99.8°, occurred at Oxford, on the 12th; lowest observed, 46.0°, occurred at Marion, on the 31st; highest on record, 103.0°, occurred in 1881 at Cape Henry, Va.; lowest on record, 46.0°, occurred in 1887 at Marion; monthly range of temperature, 53.8°; mean daily range of temperature, 15.9°; warmest day, 7.7° above the normal; coldest day, 16.2° below the normal.

Precipitation.—Average for August, 1887, 8.85 inches; normal for August, 5.61 inches; departure from the normal, + 3.24 inches; greatest local daily rainfall, 9.00 inches at Tarboro, on the 3d; greatest monthly rainfall, 22.73 inches at Tarboro; least monthly rainfall, 3.13 inches at Chattanooga, Tenn. Daily rainfalls (exceeding one inch): Tarboro, 9.00 inches; Southport, 4.80 inches; Mount Pleasant, 4.47 inches; Raleigh, 4.46 inches; Marion, 3.00 inches; Charlotte, 2.95 inches; Weldon, 2.61 inches; Hatteras, 2.50 inches; Knoxville, Tenn., 2.46 inches; Lenoir, 2.30 inches; Reidsville, 2.24 inches; Monroe, 2.05 inches; Oxford, 1.90 inches; Salisbury, 1.90 inches; Norfolk, Va., 1.77 inches; Chattanooga, Tenn., 1.61 inches.

Relative Humidity.—Mean for August, 1887, 80.9 per cent.; normal for August, 74.5 per cent.; departure from the normal, + 6.4 per cent.

Winds.—Prevailing direction for August, 1887, N. E.; average direction for August, N. E.; highest velocity, 82 miles S. E. on the 20th, at Hatteras.

Weather.—Average number of clear days, 10.4; average number of fair days, 13.6; average number of cloudy days, 7.0; average number of rainy days, 13.6.

Droughts.—Longest duration of: At Reidsville, 11th to 15th, inclusive, 5 days; Weldon, 7th to 12th, inclusive, 6 days; Oxford, 9th to 12th, inclusive, 4 days; Monroe, 9th

to 12th, inclusive, 4 days; Waynesville, 4th to 13th, inclusive, 10 days; Mt. Pleasant, 9th to 12th, inclusive, 4 days; Salisbury, 28th to 31st, inclusive, 4 days; Marion, 28th to 31st, inclusive, 4 days; Tarboro, 9th to 14th, inclusive, 6 days; Lynchburg, Va., 3d to 11th, inclusive, 9 days; Wilmington, 9th to 12th, inclusive, 4 days; Charlotte, 9th to 12th, inclusive, 4 days; Chattanooga, Tenn., 9th to 14th, inclusive, 6 days; Knoxville, Tenn., 7th to 12th, inclusive, 6 days; Southport, 9th to 15th, inclusive, 7 days; Norfolk, Va., 8th to 12th, inclusive, 5 days; Hatteras, 8th to 14th, inclusive, 7 days; Raleigh, 9th to 13th, inclusive, 5 days.

Thunder Storms.—Thunder storms occurred on the following dates: 1st, 2d, 3d, 4th, 5th, 6th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, 20th, 21st, 22d, 23d, 27th.

Miscellaneous Phenomena.—Lunar halos observed at Hatteras, on the 27th; solar halos observed at Hatteras, on the 23d, and at Lynchburg, Va., on the 12th; hail fell at Weldon, on the 18th; frost (light) occurred at Waynesville, on the 31st; red sunsets observed at Monroe, on the 3d and 24th, and at Reidsville, on the 18th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, SEPTEMBER, 1887.

Air Pressure.—Mean for September, 1887, 30.09 inches; normal for September, 30.08 inches; departure from the normal, —.01 inches; highest, 30.41 inches occurred on the 17th and 18th at Lynchburg, Va.; lowest, 29.73 inches, occurred on the 23d at Norfolk, Va., and Wilmington.

Air Temperature.—Mean for September, 1887, 69.3°; normal for September, 70.0°; departure from the normal, —0.7°; highest observed, 101.0°, occurred at Oxford, on the 14th; lowest observed, 33.0°, occurred at Marion, on the 25th; range for the State, 66.0°; mean daily range, 19.3°; highest on record, 101.0°, occurred at Oxford, in 1887; lowest on

record, 33.0°, occurred at Marion, in 1887; warmest day, 14.5° above the normal on the 14th; coldest day, 23.3° below the normal.

Precipitation.—Average precipitation for September, 1887, 2.29 inches; normal for September, 4.33 inches; departure from the normal, —2.04 inches; greatest local daily rainfall, 2.80 inches on the 28th, at Marion; greatest monthly rainfall, 5.41 inches at Marion; least monthly rainfall, 0.43 inches at Wilmington. Rainfalls exceeding one inch: Marion, 2.80 inches; Chattanooga, Tenn., 1.83 inches; Norfolk, Va., 1.78 inches; Lynchburg, Va., 1.84 inches; Reidsville, 1.50 inches; Raleigh, 1.18 inches; Weldon, 1.18 inches; Mount Pleasant, 1.03 inches.

Humidity.—Mean for September, 1887, 74.2 per cent.; normal for September, 74.4 per cent.; departure from the normal, —0.2 per cent.

Winds.—Prevailing direction for September, 1887, south-west; average direction for September, north-east; highest velocity, 32 miles from the north-west, on the 7th, at Knoxville, Tenn.

Weather.—Average number of clear days, 11.0; average number of fair days, 13.1; average number of cloudy days, 5.9; average number of rainy days, 6.0.

Droughts.—Longest duration of: Charlotte, 1st to 14th, inclusive, 14 days; Reidsville, 1st to 14th, inclusive, 14 days; Salisbury, 1st to 14th, inclusive, 14 days; Monroe, 1st to 14th, inclusive, 14 days; Mt. Pleasant, 1st to 14th, inclusive, 14 days; Marion, 1st to 18th, inclusive, 18 days; Chapel Hill, 1st to 22d, inclusive, 22 days; Southport, 1st to 15th, inclusive, 15 days; Raleigh, 1st to 13th, inclusive, 13 days; Tarboro, 1st to 7th, inclusive, 7 days; Wilmington, 1st to 7th, inclusive, 7 days; Weldon, 8th to 13th, inclusive, 6 days; Norfolk, Va., 1st to 14th, inclusive, 14 days; Lynchburg, Va., 1st to 6th, inclusive, 6 days; Chattanooga, Tenn., 1st to 14th, inclusive, 14 days; Knoxville, Tenn., 8th to 16th, in-

clusive, 9 days; average number days (longest duration of) 12.6.

Thunder Storms—Occurred at Mt. Pleasant on the 15th; at Marion on the 15th; at Tarboro on the 29th and 30th; at Monroe on the 15th and 29th; at Reidsville on the 15th and 29th; at Wilmington on the 15th; at Lynchburg, Va., on the 14th; at Charlotte on the 15th; at Raleigh on the 29th; at Knoxville, Tenn., on the 7th.

Miscellaneous Phenomena.—Frosts occurred at Reidsville on the 2d, 4th, 20th, 26th; at Mt. Pleasant, Raleigh, Marion, Tarboro, Chapel Hill, Monroe, Salisbury, Weldon, Charlotte, Lynchburg, Va., Chattanooga, Tenn., on the 25th; at Knoxville, Tenn., on the 7th; lunar halos observed at Raleigh, Charlotte, Lynchburg, Va., on the 26th; solar halos observed at Marion on the 14th and 15th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, OCTOBER, 1887.

Air Pressure.—Mean for October, 1887, 30.05 inches; normal for October, 30.14 inches. departure from the normal, —.09 inches; highest, 30.48 inches occurred at Lynchburg, Va., on the 16th; lowest, 29.51 inches occurred at Hatteras on the 31st; range for the State, 0.97 inches.

Air Temperature.—Mean for October, 1887, 58.4°; normal for October, 60.8°; departure from the normal, —2.4°; mean maximum temperature, 67.4°; mean minimum temperature, 50.2°; mean daily range temperature, 17.2°; highest, 92.0°, occurred at Chapel Hill on the 10th; lowest, 47.0°, occurred at Knoxville, Tenn., on the 31st; range for the State, 64.1°; highest on record, 94.0°, occurred at Knoxville, Tenn., in 1884; lowest on record, 25.0°, occurred at Knoxville, Tenn., in 1876.

Precipitation.—Average precipitation for October, 1887, 5.24 inches; normal for October, 3.83 inches; departure

from the normal, + 1.39 inches; greatest local daily rainfall, 4.18 inches, occurred at Raleigh on the 31st; greatest monthly rainfall, 11.21 inches, occurred at Chapel Hill; least monthly rainfall, 1.80 inches, occurred at Asheville; daily rainfalls, exceeding one inch: Raleigh, 4.18 inches; Hatteras, 3.54 inches; Weldon, 3.41 inches; Mt. Pleasant, 2.80 inches; Wilmington, 1.84 inches; Tarboro, 1.72 inches; Charlotte, 1.68 inches; Salisbury, 1.47 inches; Norfolk, Va., 1.34 inches; Marion, 1.28 inches; Southport, 1.26 inches; Monroe, 1.27 inches; Knoxville, Tenn., 1.19 inches; Kitty Hawk, 1.15 inches; Lynchburg, Va., 1.02 inches, Chattanooga, Tenn., 1.02 inches.

Humidity.—Mean for October, 1887, 74.5 per cent.; normal for October, 74.5 per cent.; departure from the normal, 0.0 per cent; highest monthly mean, 82.2 per cent., occurred at Mount Pleasant; lowest monthly mean, 66.5, occurred at Knoxville, Tenn.

Wind.—Prevailing direction for October, 1887, N. E.; average direction for October, N. E.; highest velocity, 70 miles from the East, occurred at Kitty Hawk on the 30th; average monthly wind movement, 4859 miles; greatest monthly wind movement, 10,177 miles, occurred at Hatteras; least monthly wind movement, 2294 miles, occurred at Lynchburg, Va.

Weather.—Average number of clear days, 14.2; average number of fair days, 6.0; average number of cloudy days, 10.8; average number of rainy days, 11.0.

Droughts.—Droughts generally prevailed from the 1st to 10th, inclusive.

Thunder Storms.—Thunder storms occurred at Hatteras on the 1st and 31st.

Miscellaneous Phenomena.—Light frosts occurred on the 5th, 6th, 14th, 15th, 31st; killing frosts on the 12th, 13th, 16th, 22d and 23d; ice reported at Weldon on the 23d; snow fell at the following places: Lenoir, Hot Springs, Ma-

rion, on the 30th; Raleigh on the 31st; hail fell on the 30th and 31st; sleet fell on the 30th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, NOVEMBER, 1887.

Air Pressure.—Mean for November, 1887, 30.12 inches; normal for November, 30.20 inches; departure from the normal, —.08; highest observed, 30.74 inches, occurred at Lynchburg, Va., on the 30th; lowest observed, 29.48 inches, occurred at Charlotte and Lynchburg, Va., on the 19th; range for the State, 1.26 inches.

Air Temperature.—Mean for November, 1887, 48.2°; normal for November, 49.7°; departure from the normal, —1.5°; highest observed, 77.0°, occurred at Marion on the 4th; lowest observed, 12.0°, occurred at Hot Springs and Marion on the 21st; range for the State, 65.0°; highest on record, 83.0°, occurred at Wilmington in 1877; lowest on record, 11.5°, occurred at Knoxville, Tenn., in 1872.

Wind.—Prevailing direction for November, 1887, S. W.; average direction for November, N. E.; highest velocity, 47 miles from the North, occurred at Hatteras on the 29th; average monthly movement of wind, 4,543 miles.

Precipitation.—Average rainfall for November, 1887, 1.09 inches; normal rainfall for November, 4.09 inches; departure from the normal, —.3.00 inches.

Humidity.—Mean relative humidity for November, 1887, 70.4 per cent.; normal relative humidity for November, 70.6 per cent.; departure from the normal, 0.2 per cent.

Weather.—Average number of clear days, 14.9; average number of fair days, 9.6; average number of cloudy days, 5.5; average number of rainy days, 4.6.

Atmospheric Phenomena.—Frosts occurred on the following dates: 1st, 2d, 3d, 4th, 5th, 6th, 7th, 11th, 12th, 13th, 15th, 16th, 21st, 22d, 23d, 24th, 25th, 29th, 30th; lunar halos ob-

served at Charlotte on the 21st, 22d, 23d, 24th, 25th; at Mt. Pleasant on the 23d, 25th; at Tarboro and Weldon on the 25th, 26th; at Hatteras and Chattanooga, Tenn., on the 25th; ice reported at Monroe on the 1st, 2d, 3d, 12th, 13th, 21st, 22d, 29th, 30th; at Mt. Pleasant on the 6th, 7th, 12th, 13th, 16th, 21st, 22d, 23d, 29th, 30th; hail fell at Weldon on the 20th.

Thunder Storms.—Thunder storms occurred at Lynchburg, Va., on the 14th, 15th; at Wilmington on the 19th.

METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, DECEMBER, 1887.

Air Pressure—Mean for December, 1887, 30.12 inches; normal for December, 30.17 inches; departure from the normal, —.05 inches; highest recorded, occurred at Norfolk, Va., on the 1st, 30.74 inches; lowest recorded, occurred at Norfolk, Va., on the 17th, 29.24 inches; range for the State, 1.50 inches.

Air Temperature.—Mean for December, 1887, 42.6°; normal for December, 41.6°; departure from the normal, + 1.0°; highest observed, occurred at Chapel Hill on the 4th, 68.0°; lowest observed, occurred at Lynchburg, Va., on the 30th, 12.9°; range for the State, 55.1°; mean daily range of temperature, 15.7°; highest on record, occurred in 1879, at Wilmington, 78.0°; lowest on record, occurred in 1880, at Knoxville, Tenn., and Lynchburg, Va., —5.°.

Precipitation.—Average for December, 1887, 4.75 inches; normal for December, 4.85 inches; departure from the normal, —0.10 inches; greatest local daily rainfall, occurred at Hatteras on the 10th, 3.10 inches; greatest monthly rainfall, occurred at Southport, 7.78 inches; least monthly rainfall, occurred at Asheville, 2.07 inches; daily rainfalls, (exceeding one inch): Hatteras, 3.10 inches; Southport, 3.00 inches; Davidson College, 1.49 inches; Weldon, 1.37 inches; Salem,

1.60 inches; Chapel Hill, 2.90 inches; Kitty Hawk, 1.30 inches; Lynchburg, Va., 1.26 inches; Raleigh, 1.18 inches.

Relative Humidity.—Mean relative humidity for December, 1887: Mean, 77.6 per cent.; normal, 73.6 per cent.; departure from the normal, + 4.0 per cent.

Wind.—Prevailing direction for December, 1887, N. E.; average direction for December, S. W.; highest velocity, 48 miles, from the West, occurred at Hatteras on the 17th.

Weather.—Average number of clear days, 6.2; average number of fair days, 11.6; average number of cloudy days, 13.2; average number of rainy days, 12.6.

Thunder Storms.—Thunder storms occurred at Hatteras on the 11th.

Atmospheric Phenomena.—Killing frosts occurred on the following dates: 1st, 2d, 6th, 7th, 12th, 13th, 14th, 16th, 19th, 23d, 27th, 30th, 31st; hail fell on the 17th, 24th; snow fell on the 25th; lunar halos observed on the 20th, 21st, 22d.

NOTE.

It is proposed in the next annual report of the Weather Service to have monthly and annual means of results from each of the Observing Stations given in tabulated form, as well as to give annual and monthly summaries for the whole State.

With this data it is thought that the weather reports will be more easy of reference, as well as more valuable to the State at large.

EXPERIMENT FARM.

Report of the Superintendent.*

During the year 1887, the work of the farm has been carried on as heretofore, in the field, plant house and laboratory. A lack of sufficient money and other causes rendered it necessary in the Spring to discontinue some of the work already under way, and has prevented, in great part, the extension of other important work on some of the cotton and tobacco soils of the State, which our experience and results of last year convinced us would be of practical value to our farmers. This work has been continued on the farm so far as circumstances would permit. Unfortunately, it is not generally realized that the highest standard of work in our agricultural as in our educational institutions will, in the end, be of the greatest practical value. We forget that the recent advances in practical agriculture originated from, and are based on, the most profound investigations of the German Universities. In our practical and progressive age, we are forgetting the goose that lays the golden egg. Prof. Remsen aptly puts it: "the experience of the world has shown that where the most of this so-called impractical work is done, there the most practical results are reached. * * And it may be said with confidence that the most impractical work is the most practical."†

The work carried on and treated of in this report may be summarized, as follows:

General experiments with cotton have been carried on to

*Milton Whitney.

†From address at anniversary of the Johns Hopkins University, Baltimore, February 22, 1888, as reported.

determine the yield under high manuring, the relative practical value of seven so-called varieties, the effect on the yield and time of ripening, of the distance of planting; on the improvement of poor cotton land by peas, compared with commercial fertilizers, some manure experiments on the development of the cotton plant and on the adaptability of the Sea Island cotton to our soil and climate.

The work on grasses includes a continuation of our work commenced last year, and has been further extended to a study of the habits and adaptability of other varieties and mixtures for hay and pasture. There have been 42 varieties of our most valuable grasses and clovers under careful study and observation on the farm, alone or in suitable mixtures for the various soils, climatic conditions and needs of the State. Our thanks are due Messrs. J. M. Thorburn & Co., Seedsmen, New York, for supplying us with many of these seeds free of charge.

A number of our most important forage crops were grown on adjoining plots to compare their habits of growth, yield as forage, and by chemical analysis, the relative feeding value of each. It has been impossible to complete the analyses in time for this report.

At the suggestion of a committee of the State Horticultural Society, a small vineyard of 290 vines, containing 121 varieties of grapes, together with a number of varieties each of apple, peach, pear and other fruit and nut trees, were set out in the winter and spring for study and future experimental work.

Other farm and garden work, with wheat, Indian corn, oats, turnips, &c., will be described in the body of the report.

A set of pot experiments with cotton was undertaken in the plant-house to test the relative fertilizing value of phosphoric acid in Thomas slag, lime phosphate (ground rock phosphate), dissolved bone, bone meal, and South Carolina floats. Another, to test the effect of different amounts of moisture in the soil on the development and yield of cotton,

the result of which, together with notes and observations on other experimental work conducted in the plant-house, will be found in this report.

Investigations on the temperature, moisture, specific heat, and radiation of our different soils, with record of the wind, sunshine, rain, humidity and other meteorological data, will be found in the report, together with a general discussion of the climatic conditions which have prevailed during the growing season. This work has required over 8,000 observations on the temperature of the air and soil alone.

During the year sixteen pages of original matter, descriptive of the farm work, have been published in THE BULLETIN, part of which will be used in the preparation of this report.

FIELD EXPERIMENTS.

Seven "Varieties" of Cotton.—An attempt was made to study the relative value of some well known so-called varieties of cotton, with a view of determining any practical difference to a farmer as to the kind of cotton planted.

For these experiments a strong, heavy loam soil was selected inside the "ring" of the race track in the Fair Grounds. The soil contains much red clay, but is naturally well drained, as described last year, by numerous thin veins of finely broken quartz rock, extending nearly vertical to the horizon. It was our object to give the plants all the food and the benefit of all the light, air and other conditions of plant growth possible, to insure the relative prevailing cause to make one plant produce more than another, to be the producing power of the plant itself. The land was thoroughly and deeply plowed, 600 pounds per acre of an ammoniated superphosphate sown broadcast over it, and rows three feet wide were run off, ridged and bedded up in the usual way. The top of the bed was knocked off and checked every two and one-half feet. Six to eight seed were counted out, dropped by hand in the check and covered by

the foot, at the same time pressing the earth firmly over the seed. The three feet rows ran east and west, and were each numbered by temporary stakes in the field, and permanently in the note book. There were eight lots of cotton planted, giving eighteen single rows to each kind, so arranged and placed over the whole field that the different kinds were mixed up and did not come together oftener than was necessary. This was done to overcome the error due to uneven fertility in the different parts of the field, as far as possible, and so that a row of tall growing cotton should not shade or always be next to a row of shorter cotton, as they would be if the same succession was continued in planting the field. This gave to each lot of cotton about one-eighth, or more exactly, 12.19 per cent. of an acre. Finally one plant was left standing every two and a half by three feet, when possible, but when hills were missing they were not replanted, as it was desirable to determine the relative time of ripening of each kind. The cotton was planted on April 23d, the kinds used being as follows:

1. Peterkin, presented by Mr. R. E. Clark, agent, Fort Motte, S. C.
2. Mammoth Prolific, presented by Mr. T. J. King, Louisburg.
3. Pearce, presented by Mr. T. J. King, Louisburg.
4. Mammoth Prolific, duplicate of No. 2.*
5. Ozier Silk, bought of J. H. Alexander, seedsman, Augusta, Ga.
6. Peerless, bought of Mr. Geo. Shellem, Raleigh.
7. Brady, presented by Mr. W. G. Upchurch, Raleigh.
8. Common Seed, bought of a colored man, Wm. Wilder, in Mason Village, near Raleigh, representing, as was supposed, what is commonly planted around here by the small farmers.

The cotton was picked at stated times as below, but never

*Mr. King's cotton arrived in three lots contained in the same package, and it was believed to represent three kinds of cotton, and they were at once planted as such by number. A letter, however, received shortly after showed two of these to be Mammoth Prolific, taken from the same lot of seed. The results from Nos. 2 and 4 thus serve as duplicate and furnish some interesting data.

with dew or rain on the lint, and the product from each variety was immediately weighed that day or the following morning. It is from these weights that the per cent. of each picking is recorded. On November 29th, eleven days after the last November picking, the product of each variety of cotton was weighed, when the loss in weight, due to drying, was found to be very small. This weight of November 29th, together with the fresh weight of the last picking, January 6, is used in all other cases.

The cotton was ginned November 30, and the lint of each variety weighed separately as it came from the condenser of the gin, on the same scales the seed cotton was weighed on. The roll was of course emptied each time and the seeds put in separate sacks for weighing.

The actual weight of seed cotton from the whole field of nearly an acre (97.60 per cent.) was 1,587 pounds. The detailed results are given in Table I.

TABLE I.—YIELD OF SEVEN SO-CALLED VARIETIES OF COTTON.

	NAME OF COTTON.	1st Picking Sept. 15–17.	2d Picking Oct. 5–6	3d Picking Oct. 15.	4th Picking Nov. 16–18.	5th Picking Jan. 6.	Yield of Seed Cotton.	Lint in Seed Cotton.	Missing Plants.	CORRECTED YIELD PER ACRE. Seed Cotton.	CORRECTED YIELD PER ACRE. Lint.
		Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Lbs. Oz.	Per Ct.	Per Ct.	Pounds.	Pounds.
1	Peterkin	30.02	26.17	18.81	18.56	6.43	219-8	34.65	22.65	2,328	807
2	Mammoth Prolific	19.99	33.33	21.22	20.95	4.51	207-15	31.04	29.21	2,381	739
3	Pearce	32.28	34.63	18.47	10.67	4.00	187-8	32.19	28.21	2,143	690
4	Mammoth Prolific	19.21	34.89	22.50	18.59	4.79	198-6	30.48	28.21	2,293	699
5	Ozier Silk	29.35	39.37	17.30	10.99	2.95	196-11	30.13	29.77	2,292	681
6	Peerless	30.04	34.74	18.18	14.10	2.94	190-8	30.76	24.64	2,075	638
7	Brady	10.91	41.66	24.35	18.45	4.63	173-13	31.72	19.80	1,778	564
8	Common Seed	27.53	34.76	19.66	13.60	4.44	212-10	30.37	21.94	2,228	677
	Mean	24.92	34.94	20.06	15.74	4.34	198.6	31.42	25.55	2190	687

NOTE.—The per cent. of pickings is that of the fresh weight of seed cotton. The yield of seed cotton is from the dry weight, Nov. 29, together with fresh weight of last picking, Jan. 6.

Per cent. of lint is found from weights of seed cotton, Nov. 29, and the lint as weighed at the gin.

It would be well, before discussing these results at length, to see if these cottons, known under different local names, are really "varieties," and what constitutes desirable qualities in a cotton, whether yield, fineness, length of staple, and so on.

Botanically, cotton is not well understood. The origin of most of the species is unknown, and authors cannot decide how many species there are.

De Candolle says:* "This author (Dr. Masters) agrees with Parlatore in admitting seven well known species and two doubtful, while Todaro counts fifty-four, of which only two are doubtful, reckoning as species forms with some distinguishing character, but which originated and are preserved by cultivation."

Parlatore's use of the term "species," refers to those which exist naturally in the wild state, while under Todaro's definition of the term "species" as applied in this case, we might well recognize several species or variety among our common cottons. Our common cottons are generally known to botanists as belonging to the species *gossypium herbaceum* of Linnaeus, while the species so well known under cultivation as our Sea Island cotton, ranks, according to Todaro, as *gossypium marltimum*, while Parlatore classes it with *gossypium barbadense* of Linnaeus. And others call it *gossypium nigrum.*

It is little wonder, considering the confusion and uncertainty concerning the origin and classification of our well known and distinctly marked species, that there should be such confusion and so little known about the "*varieties*" in our Southern cotton fields. We need such work as this. Botany should tell us of the home, peculiarity and habits of the wild species; whether varieties now unknown could not be formed under hybridization, cultivation, &c., and also define the differences which already exist, explaining

*Origin of Cultivated Plants, p. 403.

in part how they arose, how they can be produced or increased, and their value.

The census of 1880 says fifteen varieties of cotton were reported in common use in this State. It is probable that many of these are but improved strains of one and the same variety, just as one tries to improve a corn or tobacco crop by care in the preparation and selection of seed.

The commercial value of the ordinary grades of cotton depends less upon its natural quality than upon the care with which it is prepared for market. Mr Edward Atkinson says the determining points are: 1. freedom from trash; 2. the greater or less injury done to the staple in ginning. After this the length, color and fineness of fiber is at times considered.

Practically, then, when the short and medium staple only can be grown, we want the cotton which, under given conditions, will produce the largest yield per acre, and which will contain the least trash. A trash which a sample of lint contains, while depending largely upon the season and the care exercised in picking and preparing for market, is dependent, to a considerable extent, upon the plant itself.

Samples of the eight lots of cotton (Table I) were submitted, by number, to a cotton expert of this city. All the samples were graded by him as strict middling, worth in that day's market (Jan. 13) nine and seven-eighths cents per pound, save No. 5 (Ozier Silk), which was classed as middling. The relatively large amount of trash contained in this sample, evidently due to the "variety" of cotton, reduced the value to nine and three-fourth cents per pound. No. 2 (Mammoth Prolific, one of the duplicates), was hardly strict middling, but was so rated. No. 3 (Pearce), was a better grade than No. 4 (Mammoth Prolific), but an advance of one point was hardly justified. No. 5 (Ozier Silk), had the longest staple, but also the most trash in the sample. No. 8 (Common Seed), had the finest staple, but it was also the shortest. The color of the cotton was a creamy white,

and the samples were all pronounced of a very excellent quality. The cotton was picked by careful hands, who were generally changed at each picking. This is the only place in which the treatment of the several varieties could have differed, and consequently great care was exercised in the picking.

The earliness of a cotton may naturally affect the yield under circumstances of *season* and of the ravages of the caterpillar. Although the influence of soil and cultivation plays a most important part in the ripening of a cotton, the effect due to variety is probably not inconsiderable, and deserves careful study.

TABLE II.

YIELD OF SEED COTTON AFTER EACH PICKING.

	NAME OF COTTON.	1st Picking Sept. 15–17.	2d Picking Oct. 5–6.	3d Picking Oct. 15.	4th Picking Nov. 16–18.	5th Picking Jan. 6.
		Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.
1	Peterkin	30.02	56.19	75.00	93.56	All.
2	Mammoth Prolific	19.99	53.32	74.54	95.49	"
3	Pearce	32.28	66.91	85.38	96.05	"
4	Mammoth Prolific	19.21	54.10	76.60	95.19	"
5	Ozier Silk	29.35	68.72	86.02	97.01	"
6	Peerless	30.04	64.78	82.96	97.06	"
7	Brady	10.91	52.57	76.92	95.37	"
8	Common Seed	27.53	62.29	81.95	95.55	"
	Mean	24.92	59.86	79.92	95.66	"

Our results, as given in Table II, show that after the second picking, Oct. 5–6, 59.86 per cent. of our cotton had been picked. Four varieties were later than this: Peterkin, Mammoth Prolific (2), and Brady. The earliest, Ozier Silk, was 68.72, or 16.15 per cent. higher than the lowest (Brady 52.57). On the first picking, 32.28 per cent. of the Pearce was picked, against 10.91 per cent. of the Brady, or 21.37 per cent. more of the former than of the latter. After the

third picking, Oct. 15, the average picked up to that time was 79.92 per cent. The Peterkin, Mammoth Prolific (2), and Brady were still behind, one sample of the Mammoth Prolific being at this time the lowest, or 11.48 per cent. lower than Ozier Silk. After the fourth picking the yields are closer, the Peerless leading the Ozier Silk by only 0.05 per cent., and the Peterkin (lowest this time) by 3.50 per cent. It must not be understood that any special importance is attached to the slight differences in the time of ripening as expressed in the table. It is only a quality which should be considered in such an investigation as this, one which may or may not be shown to have definite value in particular circumstances, and which, if advisable, could probably be materially increased by judicious selection. It is stated that in certain sections of Georgia, an early variety of cotton is sought after to escape, in great part, the ravages of the caterpillar.

On account of this work it was not considered advisable to replant the missing cotton, so at the end of the growing season the number and per cent. of missing plants was found and allowance made in the usual way in calculating the yield per acre. On the average, 25 55 per cent. of the plants were missing. As the number for each variety varies somewhat from this, it would evidently not be just to accept the actual yield obtained, for in some cases there will be actually more plants on the same area than in others. On the other hand, as we shall see in discussing the yield of the distances of planting, the corrections usually applied, which supposes there would have been a proportionally greater yield if all the plants had stood, is probably much too large. The actual yield of 1,587 pounds of seed cotton obtained over the whole area of nearly an acre, would be 2,190 pounds, if this correction is made, and a perfect stand is assumed. However, it seems advisable for purposes of comparison, that this correction be made, as has been done.

The per cent. of lint was found from the first four pick-

ings, the seed cotton being weighed Nov. 29, and the entire lint of each kind as it left the condenser of the gin.

The proportion of lint in seed cotton is, on the whole, tolerably uniform, and they should have been considered very satisfactory, had not the difference of 0.56 per cent between the duplicates, Nos. 2 and 4, and an even greater difference in the Peterkin cotton, under different conditions of high manuring, soil and distance of planting, suggested either that the limit of error in our work was nearly as large as the difference supposed to be due to the variety, which, with such large quantity of material, is rather doubtful, or that the per cent. itself is very variable, dependent upon causes of which we know little at present.

TABLE III.

STATE.	Number of Samples Examin'd	Per Cent. of Lint.	Greatest Per Cent. Found.	Least Per Cent. Found.
Alabama	60	32.96	41.98	26.62
Arkansas	13	32.85	38.23	28.64
Arizona	4	27.91	31.67	24.16
California	19	32.01	39.78	23.45
*Florida	45	29.14	36.76	†11.45
Georgia	52	33.18	41.57	24.54
Indian Territory	2	31.87	32.26	31.48
Louisiana	24	33.08	43.79	20.46
Mississippi	18	34.01	39.26	31.87
Missouri	6	31.62	34.21	28.30
North Carolina	94	33.21	40.13	19.50
South Carolina	26	31.62	37.68	27.77
Tennessee	7	33.10	37.41	30.37
Texas	72	32.34	42.10	23.16
Virginia	8	34.44	41.93	29.90

*Mostly Sea Island cotton.

†Sea Island cotton.

The data of Table III, taken from the census report, 1880, shows the variable per cent. of lint in seed cotton in the different States, a result, of course, of all conditions of climate, soils, variety and cultivation.

Excepting Florida and Louisiana, the greatest extreme is in North Carolina, and both samples from Craven county. The highest, 40.13 per cent. of lint, from a light sandy soil, manured, the lowest, 19.50 per cent., from stiff clay hummock land, the former yielding 20.63 per cent. more lint from the seed cotton than the latter. The variety is not stated in either case.

This is a matter needing investigation, not only to see if the per cent. of lint, under very similar treatment, will be constant for each variety, but to determine the controlling cause in the effect of soil, cultivation, season and manure on the per cent. of lint, with a view of improving the strain or variety.

The estimation of the yield per acre of the varieties, as given in Table I, the resultant of all the factors of plant development, and the most important determining quality for the valuation of our common cottons, is probably comparable, although the absolute values are evidently too high. The result of the duplicate test with the Mammoth Prolific shows, however, that the limits of error, if such they be, are quite large. A difference of about $9\frac{1}{2}$ pounds in the actual yield of seed cotton, grows to 88 pounds per acre of seed cotton, with the difference of 1 per cent. in the stand added, and to 40 pounds per acre in *lint*, when the difference of 0.56 per cent. in the proportion of lint is also considered. This would indicate that differences of at least 50 pounds of lint per acre should not be considered. The common seed is only second in actual yield of seed cotton—but little behind the Peterkin—while in corrected yield of lint per acre it holds sixth place, and is 130 pounds behind the Peterkin. The greatest difference in estimated yield of lint per acre, is between the Peterkin (807) and the Brady (564), amounting to no less than 243 pounds per acre.

Excepting these two extremes and the Peerless, which is low, the other cottons seem to have yielded equally well, and we must look to other points to determine their relative

merits. The Ozier Silk contained more trash, which lowered its value one-eighth of a cent per pound which, with its yield already below the average, would probably not be compensated for by the somewhat better staple The common seed will probably have to be dropped from our list, although by comparing it with the Ozier Silk and others, it seems probable that the low per cent. of missing plants has unduly depressed the estimated yield of lint per acre. The staple was fine but short. There seems little choice between the Mammoth Prolific and the Pearce; the yield appears to be slightly in favor of the former, and the per cent. and quality of the lint in favor of the latter

It must not be understood that we attach other than a relative and local value to these results and criticisms, for it is quite possible that under other conditions of soil, season, manuring and cultivation, the relative values would be materially modified. Such work as this should be done by the farmers themselves, and is being done by some.

The Experiment Station is to *supplement* the work of the farmers. With more means and better facilities, we would have studied this matter in a different way.

Until more is known of the real varieties, it would be better for us to look upon most of the so-called varieties of cotton as strains, and realize that most of them probably originate from purely local causes of soil, cultivation or careful selection of seed; that by giving proper attention to these points any one can improve a crop, while on the other hand, by neglecting these points, these strains, unlike true varieties, very quickly lose their valuable characteristics.

Last year the Peterkin seed used by us was obtained from Mr. R. M. Claffy's farm, adjoining Mr. Peterkin's, as the crop of the latter was badly damaged by worms. The yield with us was considerably below the other four "varieties" tested. This year Mr. Peterkin regrets that our trial was not made with seed of his own raising, and sends, through his agent, Mr. Clark, a sample of seed which he claims to be superior

to anything he has yet had. Obviously to maintain a strain of this kind, care must be exercised in the selection of seed. It is probable, however, that even if care is exercised, a strain may deterioate naturally, or run out, as the Peerless and other well known "varieties" have probably done.

Effect of High Manuring on the Yield of Cotton.

At the January meeting the Board directed us to see how much cotton, Indian corn and tobacco could be raised per acre on small plots of one-tenth acre each. Land was selected of the same character (heavy clay loam), and just across the road from the "varieties."

A plot containing one-tenth of an acre was measured off for cotton, plowed deeply, four tons *per acre* of compost added, containing cotton seed, acid phosphate, kainite, stable manure and rich soil. The land was then plowed twice with single plows, 1,000 pounds *per acre* of an ammoniated superphosphate added, three foot rows ridged and bedded as usual, Peterkin seed (from same lot as used in the varieties), planted in checks $2\frac{1}{2}$ x 3 feet, April 23. The crop was thoroughly cultivated as needed, but was not replanted. The plants were well bolled, and there was little or no inclination to run to weed. The results appear as part of Table IV, page 128.

It must be observed that this was decidedly a rich, strong piece of land, in good "heart," far better than any of the farm lands proper. The yield of 861 pounds of lint per acre would seem very large, but compared with the same cotton among the varieties (807 pounds), the increase almost falls within the limit of error suggested for these experiments, and is in no wise proportionate to the extra cost of manuring on the tenth acre.

The question arises, was the limit of the productive powers of the plant nearly reached among the varieties, so that an excess of food, as in the case of an animal, would not

give increased development, or was the limiting cause some other factor of plant growth above or below the surface of the ground?

Compared with similar seed among the varieties, the high manuring does not seem to have materially affected the earliness of the plants. The per cent. of lint is more than one per cent. less. It seems to the writer that this per cent. of lint must be an extremely variable quality between comparatively wide limits. The *per cent.* of missing plants is very much less under the high manuring, and this, together with the low per cent. of lint, may account in part for the relatively smaller difference in yield than was to have been expected.

Effect of the Distance of Planting on the Ripening of Cotton.

Four plots of approximately one-tenth acre* on land adjoining the experiments just described, 380 pounds *per acre* of an ammoniated superphosphate sown broadcast, and rows run and bedded as usual. Peterkin cotton seed, from the same lot as already described, was planted as follows: In one plot the seed was drilled in the row, and at the proper time chopped to a stand of "9 inches," as is usually done. The remaining plots were planted in checks of respectively 2 x 3 feet, 3 x 3 feet, and 4 x 4 feet. Eight seeds were dropped in each check and chopped to a stand of one plant where possible, but no replanting was done. The land was considered tolerably uniform in fertility, but as the season advanced it became evident that the soil was rather better in the 9-inch cotton than in the 4 x 4 feet at the other extreme of the series. The results appear in Table IV.

* The area for the 4 x 4 foot cotton was just $\frac{1}{10}$ acre, the other three plots were each 0.09845 of an acre.

TABLE IV.—ONE-TENTH ACRE UNDER HIGH MANURING AND EFFECT OF DISTANCE OF PLANTING.

	1st Picking Sept. 15–17.	2d Picking Oct. 5–6	3d Picking Oct. 15.	4th Picking Nov. 16–18.	5th Picking Jan. 6.	Yield of Seed Cotton.	Lint in Seed Cotton.	Missing Plants.	CORRECTED YIELD PER ACRE. Seed Cotton.	CORRECTED YIELD PER ACRE. Lint.
	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Lbs. Oz.	Per Ct.	Per Ct.	Pounds.	Pounds.
$\frac{1}{10}$ acre	25.80	33.27	22.16	13.68	5.09	233-7	33.59	8.90	2,562	861
3 feet x 9 inches	22.96	24.58	23.18	20.53	8.73	192-5	35.09	13.43	2,320	814
3 x 2 feet	23.31	31.25	22.39	15.52	7.51	202-0	35.83	9.75	2,161	774
3 x 3 feet	19.93	29.15	26.79	16.10	8.02	186-7	35.93	15.79	2,249	808
4 x 4 feet	14.40	23.93	26.18	21.89	13.59	124-3	35.72	25.67	1,671	597

YIELD OF SEED COTTON AFTER EACH PICKING.

	1st Picking Sept. 15–17.	2d Picking Oct. 5–6	3d Picking Oct. 15.	4th Picking Nov. 16–18.	5th Picking Jan. 6.
	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.
$\frac{1}{10}$ acre	25.80	59.07	81.23	94.91	All.
3 feet x 9 inches	22.96	47.54	70.72	91.25	"
3 x 2 feet	23.31	54.56	76.95	92.47	"
3 x 3 feet	19.93	49.08	75.87	91.97	"
4 x 4 feet	14.40	38.33	64.51	86.40	"

It is generally believed that close planting hastens the maturity of the cotton plant, and our results seem to bear out this impression, except with the 9-inch cotton, which falls behind after the first picking, due probably to the slightly richer and damper soil of that plot. Under the conditions which have prevailed here, the Peterkin cotton has shown a much higher per cent. of lint in the seed cotton than elsewhere. The 9-inch cotton is more than three-quarters of one per cent. lower than the other for some unknown reason. Leaving this out of account, the other per cents. of lint are about $1\frac{1}{4}$ per cent. higher than the same seed among the varieties, and about $2\frac{1}{4}$ per cent. higher than the $\frac{1}{10}$ acre under high manuring. The proportion seems to decrease as the manure increases, thus with 380 pounds fertilizer per acre, about 35.83 per cent. of lint (9-inch cotton not included), 600 pounds fertilizer per acre, 34.65 per cent. of lint, 1,000 pounds fertilizer and four tons of compost per acre, and 33.59 per cent. of lint in the seed cotton.

Then the lower per cent. of the 9-inch cotton on what is supposed to be the richest land in that series, may be due to the same cause. The low per cent. of missing plants in the 2 x 3 feet cotton, evidently depresses the yield of lint per acre. The actual yield of seed cotton and the per cent. of lint are both higher in the 3 x 2 than the 9-inch cotton, yet the yield of lint per acre is estimated at 40 pounds less in the former than in the latter case.

The high per cent. of missing plants in the 4 x 4 feet cotton, probably raises the estimated yield of that plot considerably above what it should be. Leaving out of account the 4 x 4 feet cotton, which is evidently not planted close enough for the most economical production, a comparison of the actual yields of seed cotton from the other plots seems to show a very close agreement and helps to confirm the general impression among practical farmers that a cotton plant will produce in proportion to the space allowed it within reasonable limits. It is probable that this depends largely

upon the soil, season and cultivation. It throws serious doubt upon the accuracy of the correction for missing plants usually made in work of this character, and suggests that a better way would be, after the plants are well established to pull up or chop out to an equal stand.

It also suggests a considerable saving in seed and labor, if the cotton is planted in checks. This may, however, depend largely upon the soil and other conditions of plant growth. In these calculations the missing plants for the 9-inch as well as for other kinds, were those actually missing. The "9-inch" cotton was probably nearer 12 inches apart by actual measurement, so the 2 x 3 cotton can be looked upon as half a stand, and the 3 x 3 as one-third of a stand as ordinarily planted. The 9-inch cotton, of course, had the advantage of the manuring afforded in the considerably larger amount of seed used in drilling than in checking the cotton seed.

Improvement of Poor Land by Peas.

Experiments started last year on the relative merits of manuring with cow peas as compared with commercial fertilizer, and on the different ways of manuring with peas, were continued this year. The results from duplicate plots show the land to be of such uneven fertility and character that the work had to be abandoned. Probably the work will be taken up later, and some concordant results obtained.

The soil was *very* poor, and the results, as were expected, were very marked. It had been thought that with such very marked results, the influence of the different treatment could have been worked up and expressed by proportion or per cent., but this was very unsatisfactory, to say the least, and the results of the work are not given here.

Sea Island Cotton.

A tenth acre plot adjoining the varieties was planted May 4th with Sea Island cotton. The plants grew well but inclined to run to weed. They averaged about five feet high and were well limbed and well bolled.

The first picking was on Nov. 18, and the second Jan. 6, yielding a total of 329 pounds of seed cotton *per acre*. The lint was very fair length and quality, but no determination was made of the per cent. in the seed cotton. Assuming one of lint to three of seed, as is done in practice, and allowing the lint to be twice as valuable as the ordinary staple, this yield would be equivalent to about 164 pounds of lint (ordinary staple) per acre.

It was interesting to watch the development and slow maturity of the plants. The first picking was seventy days later than some common cotton on earlier land (Sept. 9) on the Experiment Farm, and sixty-five days later than the *varieties* on the land adjoining itself. The bolls were long and peaked, and evidently opened by the cold before they had matured. If this cotton had been grown on an early sandy soil, with closer planting, it would probably have done better and matured earlier.

I would not look upon our results as discouraging further effort to raise this or other long staple cotton in this and similar sections, but more as directing our investigation to a study of the controlling cause which retards the ripening of the plant. The cotton plant is peculiarly sensitive and readily responds, not only by days but by weeks, to conditions of climate, season, soil, manure, and cultivation, both as to yield and time of maturity.

Hay and Pasture Grasses and Clovers.

The work started last year (Sept., 1886), on the study of a

number of separate grasses, and on the effect of various manures and treatment on a mixture of grasses for permanent hay and pasture has been continued. In the spring (1887) some fortieth acre plots were seeded with still other varieties, but owing to a rank growth of weeds and a reduction of the farm labor, they had to be abandoned, to be taken up again in the fall, when more time, better preparation of smaller plots and a more systematic and comprehensive plan gave promise of more valuable results.

YIELD PER ACRE OF SEPARATE GRASSES AND CLOVER.

The land on which this work was conducted has a slight southern exposure extending in a long narrow strip east and west, sixteen feet from the fence, facing the Hillsboro road. When we took possession of the place this was at the edge of a small blackjack thicket, and was badly washed and gullied and cut up by wagon roads to save teams from a very muddy hill. The land had therefore to be grubbed, and this, with the repeated plowing and cross-plowing, subsoiling as deep as two mules could go, harrowing, rolling and a subsequent scraping to complete the grading, and considering the very small amount of *soil* originally on the land, must have put it into a fairly uniform condition of fertility. Except the plots of the two rye grasses, somewhat separated from the others, and inclining more to red clay, the surface is a rather heavy yellow loam resting on red clay, 10 or 12 inches down.

A dressing of stable manure, lime phosphate and kainit was plowed in as a preparation for cow peas, and a heavy growth of pea vines mowed for fodder, in September, 1886. 2,000 pounds lime phosphate and 400 pounds of kainit, *per acre*, was then broadcast, the stubble plowed in, and the land well harrowed and rolled. Plots of 1-30 acre were laid off, except those for the English and Italian rye grasses, which were of irregular shape and larger than the others, for which

due allowance is made.* The seeds were sown Sept. 15th, 1886, except the Bermuda roots planted Sept. 14th, fowl meadow Sept. 22d, and Texas blue grass Oct. 1st. When the cold weather set in each plot received a top dressing of $3\frac{1}{2}$ cart loads of stable manure, and on Feb. 5th, at the rate of 1,000 pounds bone meal and 400 pounds of kainit *per acre.* On March 28th, each plot received 3 pounds 4 ounces nitrate of soda, or 98 pounds per acre.

The object of this work is not primarily to determine the yield per acre of the grasses, but to give us small plots of the most valuable grasses growing side by side, under good treatment, that we may note their habits of growth and adaptability to our soil and climate—while not the least important feature of the work is the interest visitors take in seeing and studying the different grasses.

We were not prepared to test the value of any grass or mixture of grasses for pasture by actual grazing. A grass may be of great value for grazing, but yield a very insignificant amount of hay.

While we cannot very well graze our small plots of grasses, we had hoped, after the grass was well established, to be able, by very frequent cuttings, with a sharp scythe or lawn mower, to imitate very closely judicious grazing, and from the yield and frequent chemical analyses of the grass thus cut, determine the amount of food constituents and the relative value of the pasture grasses.

It takes at least two or three years for the true pasture grasses to become well established, so that we would have been unable to have grazed most of those we have in this year, to any considerable extent. The grasses were, therefore, all cut when in bloom as if for hay. For this reason it is quite probable that the meadow fescue, and possibly the fowl meadow grasses, and certainly the last five grasses, have

*The Italian rye grass plot is $\frac{1}{17}$ of an acre, and the English rye grass plot is $\frac{1}{21}$ of an acre.

not their true relative value in the following table of yield per acre, as all of them would have afforded considerable grazing the first year:

TABLE V.

NAME.	When Cut.	YIELD AIR DRY HAY. Per Plot. Lbs.	Oz.	Per Acre. Pounds.
Italian Rye Grass	April 27	205	4	
	May 26	83	9½	
	June 25	43	10	5,557
Johnson Grass	June 14	9	0½	
	July 21	52	9½	
	Sept. 10	109	11	5,139
Red Clover	May 16	88	4½	
	June 25	43	14	3,965
English Rye Grass	May 14	153	7½	3,229
Tall Mead. Oat Grass	May 16	99	13	2,994
Red Top	June 14	98	0	2,940
Lucerne	May 16	5	8½	
	June 25	20	8½	
	July 21	23	11	
	Sept. 10	29	4	2,370
Timothy	June 14	71	3	2,136
Fowl Meadow Grass	July 21	63	9	1,907
Meadow Fescue	May 26	51	13	1,554
Orchard Grass	May 16			
Kentucky Blue Grass				
Texas Blue Grass				
Bermuda				
Crab Grass				

ITALIAN RYE GRASS—(*Lolium Italicum*)

Is well suited for soiling cattle, being very early and yielding large and frequent cuttings. Our plot could have been grazed in February, and yielded a large cutting nearly a month before any of the other grasses were ready to be cut. We took three cuttings, yielding a total of 5,557 pounds *per acre*, but the grass was entirely killed out by the intensely hot spell in July. Our soil was badly adapted to the grass. Being a very rapid grower, the grass is a great feeder and should be on rather moist but well drained *rich* land, and

rather heavily manured after each cutting, when, in favorable seasons, the yield is said, on good authority, to be enormous. One could well afford to have a small plot of this grass near the stable and take good care of it, for the very early, nutritious and abundant feed for a cow. The grass, if grown alone, is an annual, and must be seeded each year, except under very favorable circumstances, when a late growth may be allowed to ripen and drop its own seed.

JOHNSON GRASS—(*Sorghum Halepense*).

In spite of the dread the cotton planters have of this grass and of the coarseness of the hay, if left too long uncut, it has done well with us. We put in the seed instead of root cuttings, and in consequence had a very poor stand, as can be seen by the small yield for the first cutting, but the grass spreads rapidly and we got a very good cutting in September. There is still a very poor stand, yet it yielded 5,139 pounds *air-dry* hay *per acre*. It is essentially a hot weather grass and is quickly killed by frost. We should think this power to withstand drought and its permanent character, when once established, would commend it to many of our farmers. It should be confined to a meadow, away from cotton fields, and cut frequently, at least three or four times a season.

RED CLOVER—(*Trifolium pratense*)

Is so well known that it is unnecessary to make any special remarks. It has stood the summer well, yielding two cuttings of a total yield of 3,965 pounds *air-dry* hay *per acre*, and is in fine condition to stand the winter.

ENGLISH RYE GRASS—(*Solium perenne*)

Grows about half as tall as the Italian rye grass, and was only cut once. It is a perennial, especially if mixed with

other grasses. The hot spell in July and in August entirely destroyed the grass on about half our plot. The yield, 3,229 pounds *per acre*, was good, but the grass did not stand the summer well. It did not seem to be a vigorous grower, but we look for improvement next year. It would seem to be much better adapted to seeding with other grasses than alone, and well adapted to either hay or pasture. It ripened at the same time with tall meadow, oat, orchard grass and red clover, and the four should make a good mixture for hay.

TALL MEADOW OAT GRASS—(*Arrhenatherum avenaceum*)

Is one of our most valuable and reliable grasses. It gave one cutting of 2,994 pounds per acre, stood the summer well, and would have afforded good grazing this fall had we been prepared for it It is inclined to grow in tussocks, like orchard grass, and the hay is rather coarse. If left standing too long, the stem is like wheat straw. These, as well as other qualities, show the true place of this grass to be in a mixture either for hay or pasture. The early and late growth of the grass has given it the name of "evergreen grass." The seed sown were quite impure, and although some weeding was done, after the grass was headed out there was found to be still a large number of foreign plants. A botanical separation of the air-dry hay showed 14 *per cent.* by weight of other grasses, &c., consisting of wheat, rye, Italian rye grass, meadow fescue, &c. This should by right be deducted from the weight above given to obtain the true yield of the grass.

RED TOP—(*Agrostis vulgaris*).

We had a fine close stand of this grass yielding one cutting of 2,940 pounds per acre of hay, and the sod has stood the summer well. It ripened at the same time as the timothy.

The grass is well adapted to meadows and low lands, and is hardly to be expected to do so well on our uplands, especially when growing alone.

LUCERNE—(*Medicago sativa*).

Our experience has recommended August and September as the best time to sow grasses in this section, for with spring sowing the weeds make such an early and luxuriant growth as often to completely crowd out and destroy the young grass, but on the other hand, unless the grass gets a very good start before winter, or in any case, it is liable to get winter killed. Of course, if the land is known to be free from weeds, in good condition and in good "heart," advantage can be taken of favorable seasons almost any time from August to May for sowing grass and clover seed. With lucerne, however, our experience has been different. Only about a dozen plants stood the winter, so the plot had to be reseeded in the spring, when a very good stand was secured.

As lucerne has to be kept free from weeds the first year, or until it gets well established, it is customary to sow the seeds in drills and weed as with any field crop, which we did. It is often very difficult to get a good stand either from fall or spring seeding. Lucerne should have rich, well prepared land and be frequently well manured, as it is a rapid grower and good producer of very nutritious feed. It is best adapted to feeding cows, and this in the green or wilted state, as it cures badly. A small plot of this well cared for would be valuable near a cow shed, when some could be cut each morning for the night feed. It will yield repeated cuttings and when well set and cared for should last many years. We are not yet prepared to say much, one way or the other, of lucerne for our farmers.

TIMOTHY—(*Phleum pratense*).

We continue to look with suspicion upon this grass. We have a very good stand and had one cutting of 2,136 pounds *per acre*, and the sod has stood the summer well, but its general appearance and behavior has not pleased us over well. We will hope for a more favorable opinion from a mixture of timothy and red top put in this fall. They both ripen together.

Being a late grass (cut this year, June 14th), it is more likely to suffer in our usual sharp, sudden spring droughts than most of the other grasses which ripen fully a month earlier.

FOWL MEADOW GRASS—(*Poa serotina*)

Much resembles red top in appearance. It is a late summer grass (July 21) and better suited for meadow lands for hay and pasturage than to grow alone on the upland as we have it.

It gave one cutting of 1,907 pounds *per acre*, nearly as much as timothy. It gives promise of being of value in a mixture of grasses for permanent pasture.

MEADOW FESCUE—(*Festuca pratensis*)—RANDALL GRASS

Has not come up to our expectations—still we continue to look upon it with great favor for grazing in a mixture of grasses for permanent pasture. Its habits of growth are good, and it continues fresh and green throughout the summer and fall, and seems to give considerable promise of value in spite of the low yield of hay, 1,554 pounds *per acre*. We expected some improvement next year when the sod was well established, especially if we were able to graze it some. It is said to afford excellent winter grazing as far north as Virginia.

ORCHARD GRASS—(*Dactylis glomerata*).

Most of this plot was washed out by an overflow in one of the spring rains, consequently much of it had to be reseeded, so the yield is not given. It was cut once on May 16, but on the whole we were rather disappointed from our expectation and high appreciation of the grass, observing its habits and growth, contrasted with some of the other grasses growing side by side with it. We hoped for and expected better things of it next year.

It would, undoubtedly, like most of the other grasses, do better in a mixture for hay or pasture than when grown alone.

KENTUCKY BLUE GRASS—(*Poa pratensis*)

Has not done much this year, for like most of the true pasture grasses, it takes two or three years to become thoroughly established. It has given no cutting, nor would it have afforded any grazing this year, unless for a short time late in September and in October. It is hardly expected to do much for us in its exposed, unshaded position. It is well adapted to a limestone soil and, with us, to a mixture of grasses for permanent pasture.

TEXAS BLUE GRASS—(*Poa arachnifera*)

Is another of the pasture grasses which require two or three years to become established. We put in the seeds instead of sets, which, besides being expensive, are as hard to sow as raw cotton. We could not separate them with ashes, soil or sand, and had to pick them to pieces and drop the little bunches as well as we could. We secured a very good, close stand, and after the hot weather set in the grass grew off quite well but slowly, and would have afforded some good grazing through the fall. It is now about 10 inches high and a *very* close stand. It is a grass of considerable promise—

at present more promising than the Kentucky blue for us. It is a fine leaved grass not yet headed out

CRAB GRASS—(*Panicum sanguinale*)

Continues to be looked upon with favor for its large and sure yield of hay in spite of, or rather in consequence of, our usual hot, dry summer. We did not get a very good stand on our plot from the fall seeding, and the last cutting, while drying, was mixed with the Bermuda grass by some boys, so the yield is not known.

BERMUDA GRASS—(*Cynodon dactylon*).

We got a very poor stand of this grass in spite of a large number of roots put in in the fall, and notwithstanding repeated weedings, the plot was mostly occupied by crab grass, so not much can be said this year. It has spread and we have a good stand now, and continue to look on it with favor for pasture when it can be kept out of the cotton field. The true character and value of most of these grasses will only appear after at least another year.

These remarks on the habits of some of our principal grasses are from observations of their actual growth on the soil of the Experiment Farm, or in the neighborhood of Raleigh. Under longer and more careful study, and especially under other conditions of soil, climate, season, treatment and use, our general opinion and consideration of the relative value for our farmers might change, but as the work has been abandoned for the time, our impressions and experience of this year's work are given in some detail.*

*The writer wishes to acknowledge the value and assistance Dr. Phares' little pamphlet, "Book of Grasses and other Forage Plants," has been to him in the practical study of the grasses, and advise such of our farmers as are interested in grass, directly or indirectly, to secure a copy of the book from the author, at the Mississippi Agricultural College, or from the So. Live Stock Journal, Stockville, Miss., where it is published.

Permanent Meadow and Pasture.

Experiments were started in 1886 to determine practically the best treatment for our poor and worn-out land for the establishment of a permanent grass sod. As *results* were looked for from us from the first, we could not spend the time as every farmer should to get the land up and in good heart by green manuring and judicious cropping.

The soil on which the experiments were made is a rather heavy loam, inclining to clay, with a good red clay subsoil within six or eight inches of the surface. Good surface and underdrainage, and a northern exposure (the best in this state for grass). The soil is poor, but should be easily improved, and seems well adapted to clover and wheat. Clover had been seeded two or three years before, but had not amounted to much, and when this work was undertaken the land was mostly occupied with weeds, with only occasional small patches of clover.

The land was deeply plowed in August, 1886, and after about ten days was replowed and harrowed until the surface was fine and in good condition for the seed. Twenty-four plots, fifty-eight feet one inch, by thirty-seven feet six inches, containing 1-20 acre each, were measured off with five foot walks between each. Some of the plots were then deeply subsoiled and the manure and fertilizers applied as below. The stable manure was plowed in, while the fertilizers were harrowed in deeply, in the well prepared soil, with a disk harrow, except the nitrate of soda, which was applied in the spring. The same amount of seed were weighed out and mixed separately for each plot, and garden lines were used around each plot to ensure that both the fertilizers and seeds should all fall inside the plot. The seed was sown Sept. 27 and 28, 1886, and rolled in.

QUANTITY AND KIND OF MANURE USED.

We wanted the answer to our question as decided and pronounced as possible, so our aim was, in using manures, to use about the largest quantity of each that is usually applied to the land, without regard to cost. It is one thing to determine what the land needs for the production of grass, and quite another to determine the most economical way, or form, or quantity, to supply this need. The former should, in our opinion, precede the latter inquiry. When fertilizers or manures were used, the following maximum quantities were applied:

Stable manure	150	cart loads	*per acre.*
Lime phosphate	2,000	pounds	" "
Bone	1,000	"	" "
Kainit	600	"	" "
Lime	2,000	"	" "
Nitrate of soda	100	"	" "

COST OF THE MANURING.

The result may be reckoned either in pounds per acre (for which the experiments were planned), or in connection with the cost, when the result will appear proportionately nearly the same.

The stable manure will be worth at the city stables about 25 cents per load, or $35 an acre, say for the above dressing. It is uncertain what commercial value it would have if made on the farm. The lime phosphate would cost at the factory $10 per ton, or less in quantity, and would supply 130 pounds of phosphoric acid per acre in the quantity used, accepting the average per cent. (6.50) guaranteed by the manufacturers.

One thousand pounds of ground bone, of good quality, cost last year *in Raleigh*, $20, and will supply about 180

pounds of phosphoric acid (assuming 18 per cent P_2O_5). The kainit will cost about $4.20 and the lime about $9 or $10. The nitrate of soda about $3.50.

Each kind of manuring was made in duplicate, and for fear the soil was not uniformly fertile, but would of itself give very different results on the different plots, the duplicate plots were separated as far as possible, as the diagram will show, to give a further check on the results.

40 1094 Stable manure.	46 295 Lime Phos. Kainit.	52 1891 Stable manure. Lime.	58 None. Nothing.
41 983 Bone. Kainit.	47 584 Nothing.	53 2277 Subsoiled. Stable manure. Lime.	59 515 Bone. Kainit. Lime.
42 463 Lime.	48 1584 Bone. Kainit. Nitrate of Soda.	54 154 Subsoiled.	60 2125 Stable manure. Lime Phos. Kainit.
43 2381 Subsoiled. Stable manure. Lime.	49 2808 Stable manure.	55 228 Lime Phos. Kainit.	61 140 Lime.
44 196 Bone Kainit. Lime.	50 122 Nothing.	56 145 Nothing.	62 806 Bone. Kainit.
45 11 Subsoiled.	51 2044 Stable manure. Lime Phos Kainit.	57 2609 Stable manure. Lime.	63 1078 Bone. Kainit. Nitrate of Soda.

NOTE.—The figure in the left hand corner gives the number of the plot; that in the right hand corner denotes the yield *per acre* (leaving out fractions of pounds) of the first cutting air-dry hay.

TABLE VI.

YIELD OF HAY FROM PERMANENT MEADOW AND PASTURE, 1887.

No. of Plot.	TREATMENT.	POUNDS PER ACRE, AIR-DRY HAY.				
		1st cutting May 16–17	Average.	2d cutting June 25th.	Total.	Average total yield
43	S. Manure. Lime. Subsoiled	2,381		82	2,463	
53	S. Manure. Lime. Subsoiled	2,277	2,329	578	2,855	2,659
52	S. Manure. Lime	1,891		819	1,710	
57	S. Manure. Lime	2,609	2,250	Lost		
51	S. Manure. Lime Phos. Kainit	2,044		Lost		
60	S. Manure. Lime Phos. Kainit	2,125	2,085	499	2,624	
40	S. Manure	1,094		445	1,539	
49	S. Manure	2,808	1,951	369	3,177	2,358
48	Bone. Kainit. Nitrate of Soda	1,584		Lost		
63	Bone. Kainit. Nitrate of Soda	1,078	1,331	208	1,286	
41	Bone. Kainit	983		311	1,294	
62	Bone. Kainit	806	895	204	1,010	1,152
44	Bone. Kainit. Lime	196		319	515	
59	Bone. Kainit. Lime	515	356	229	744	629
42	Lime	463		161	624	
61	Lime	140	302	Lost		
46	Lime Phos. Kainit	295		343	538	
55	Lime Phos. Kainit	228	262	240	468	501
56	Nothing	145		158	303	
58	Nothing	None		None	None	
47	Nothing	584		256	840	
50	Nothing	122	213	150	272	354
45	Subsoiled	11		None	11	
54	Subsoiled	154	82	109	263	137

NOTE.—The hay from some of the plots, for lack of room, was put to dry under an open shed in one of the courts of the Exposition Building. It was thus partly exposed to several rain and wind storms, followed by damp weather in June and July, and the hay was so much injured and blown about that the weights were not taken. This explains the blanks in the column giving the yield of the second cutting.

As the second cutting merely raises the total yield, and hardly affects the relative value of the different manures, the discussion which follows will be based mainly upon the data of the first cutting, on account of the missing weights of the second cutting.

The wide range in yield between some of the duplicate plots shows the land itself to be very uneven in character, and when one compares the yield of duplicate plots, and notes the wide variation, it seems almost hopeless to draw conclusions of positive value from the work. The widest difference between two plots similarly treated, is when stable manure is used alone, one giving the highest and the other the lowest yield of any where stable manure is used—the difference amounting to no less than 1,714 pounds *per acre.*

Other duplicates show smaller but wide variations, and we are forced to believe that the soil must be far from uniform in character in spite of the general appearance to the contrary. Still the results are sufficiently pronounced to enable us to overlook this unevenness in a measure.

In such poor, thin, undulating soils as we have to deal with, a very small element of plant growth, which might be easily overlooked, or if seen not understood, might have a value far in excess of what it would have in the deeper, richer and more fertile soils of the north. Still our results are not without practical value. In the first place, they show us something of the condition of our soil. Then when it is seen that such different results can be obtained in different portions of an acre field of apparently uniform character, with exactly the same treatment, it will easily be seen and *realized* that one may get exactly opposite results in field culture with a fertilizer or method in different portions of the same or adjoining fields.

It is very generally admitted that plot experiments with fertilizers are generally only of local value, and our results must be accepted with a great deal of caution until we know more about the soil and are better able to interpret the results.

In regard to our particular results, the *average* yields per acre differ so widely between the different treatments that we are forced to admit, as far as a single year's record can be relied on, the great value and importance of the nitrogenous manures in establishing a sod on our soil, considering the meteorological conditions which have prevailed.

They also show the probable origin of, and perhaps the reason for, the general impression that grass cannot be raised at the South.

If we had left stable manure and nitrate of soda out of our ratio, we might have felt justified in concluding that so far as our experience went, this impression was justified.

The beneficial effect of the stable manure must be due largely to the nitrogen it contains, as is indicated by the effect of the bone (containing some nitrogen) over the lime phosphate, and the effect of the relatively small amount of nitrate of soda added to two of the bone and kainite plots.

We see here what was principally lacking in the soil in an available form—nitrogen, and this will probably be found true of most of the soils which, like many of our hillsides and abandoned cotton fields, have by nature or cultivation been kept free from grass and weeds, and been washed by rains and parched and dried by sun and wind, with at best but a scanty covering of vegetation.

It is worse than useless, it is worse than extravagant, to attempt to form a sod on such land with no other work or preparation than to plow it once or twice and brush or roll the seed in with any expectation of obtaining a sod of the finer grasses.

It takes preparation and considerable outlay to establish a permanent sod on any soil, and it becomes important, in view of the fact that nitrogen seems to be the most important, as well as most costly element of plant food required by our soil, to determine the most economical form and amount to apply, and the best manner and time to apply it. Shall it be in the form of stable manure, compost, nitrate of

soda, cotton seed meal, a nitrogenous superphosphate, or by green manuring, as with clover or peas? This is a question which should be studied by itself, and indeed has been to some extent on the Farm.

For the first cutting bone and kainit increased the yield over the unmanured plots only about one-third ($\frac{1}{3}$) as much as stable manure, the cost being considerably more than half, while the increase, apparently due to lime phosphate and kainit, was about one thirty-seventh (1-37) of the increase due to stable manure, or one-thirteenth (1-13) of the increase due to bone and kainit. Although, as we have said, no strict comparison of this kind can nor should be made with our results, still we feel justified in drawing some general conclusions in the line just suggested.

ON THE NEEDS OF THE SOIL AND AN ATTEMPT TO EXPLAIN THE RESULTS.

Accepting the results as expressed in the average yields per acre (Table VI) as approximately correct and relatively comparable, we may attempt to explain them.

In the soil of a well established meadow or pasture, there is a large accumulation of organic matter from the decaying roots and leaves of the plants, containing upwards of 1,000 pounds of nitrogen per acre. This nitrogen would be contained in about one hundred tons of stable manure. Until this has accumulated, the conditions are not normal, and the one factor—nitrogen—will likely be the controlling element of plant growth. When this is the case, no amount of phosphoric acid, kainit or lime can be expected to yield much return. The increased yield, apparently due to the bone and kainit in our experiments, may have been largely due to the 30 or 40 pounds of nitrogen contained in the bones, rather than to the phosphoric acid, for the average of two other plots showed a gain of over 400 pounds of hay per acre over the yield from the bone and kainit alone, appa-

rently due to 100 pounds of nitrate of soda containing some 15 pounds of nitrogen which had been added. If this is so, the same quantity of nitrogen as is contained in the bone could have been bought for $6 or $8 in nitrate of soda, instead of $20 in the bone, and would likely have had the same *present* effect.

The present treatment of the grass plots was to continue to see if the sods formed under their agency will be permanent, for it is quite likely that some of these plots may "run out" before the sod can be considered established, also to obtain the after effect of manuring, and for further work on the after treatment of grass land, to see how the sod may best be maintained and improved from year to year. It then remains to study the sod itself, to see if that is composed of the most valuable grasses. If they are adapted to the soil, climate, use (whether for hay or grazing), and are generally adapted to the particular mixtures of grasses—if, as should nearly always be the case, several grasses are sown together.

Let us repeat, however, that these results, like those with cotton, should be accepted with caution and as applying only to our soil. The conditions and results would probably be the same in any of our average upland loams, especially if by constant, clean cultivation of cotton, the soil is deficient in the decaying organic matter of roots, &c. On bottom lands or a broken sod the results would likely be very different.

AFTER TREATMENT OF GRASS LANDS.

If the same manuring is continued on each plot for a number of years, will the results continue to be relatively the same? Evidently not. When stable manure was used, we have added about 35 tons of organic matter containing say 350 pounds of nitrogen, or one-third of what is found under a good sod. At this rate, there must soon be such an accumulation of organic matter in the soil that nitrogen will

cease to be in the relative minimum, and some other factor will be the controlling cause to limit the crop production. So that it would be unwise to apply a *heavy* dressing of stable manure to well established grass land oftener than from three to five years.

It is probable that the effect of the phosphoric acid and the kainit manuring will only be felt after a certain amount of organic matter (and nitrogen) has accumulated in the soil. As the sod grows, and more and more roots are left to decay in the soil, the yield from the plots manured continuously with phosphoric acid and kainit will likely increase, while the increase due to the stable manure will be relatively much less, until the sod is well established, when it should receive a dressing each year of phosphate and kainit, and every four or five years of stable manure. The after treatment will depend largely, however, upon local circumstances, as the grazing or cutting of the grass and general character of the soil and condition of the sod.

In the meantime, it is quite possible that any or all of the plots, but especially those which received no stable manure, may fail to establish a sod. The third year is about the most critical for a *permanent* meadow or pasture. If they stand as long as that, it is likely the manure and phosphoric acid and kainit plots, at any rate, will pull through.

The mixture of grasses used in these experiments was as follows:

Orchard grass, tall meadow oat grass, red top, Italian rye grass, meadow fescue (Randall grass), Kentucky blue grass, yellow oat grass, sweet vernal and red clover. We think now the Italian rye grass should have been omitted, and the sweet vernal is the annual instead of the perennial kind, and worthless.

It is interesting to call attention to the very luxuriant growth of red clover on all the permanent pasture plots that received stable manure, and the marked absence of the clover on the other plots receiving phosphoric acid, kainit, &c.,

although the same amount of clover seed (and grass) was put on each. This effect is so marked that those plots which received stable manure can readily be recognized from any distance that the plots can be seen from the dark green of the clover.

OTHER WORK WITH GRASSES AND MIXTURES.

There seems to be no use in attempting to put in a great variety of grasses on the Farm, but we should rather confine our attention to comparatively few, and study the best known and most valuable grasses thoroughly, and try to get these introduced into the State, and in general use by the farmers. This will provide work for some time to come.

In September the following grasses and clovers were seeded in single rows or in small plots (5 x 7 feet) for study, as of more or less promise for the different soils and needs of our State: Meadow foxtail (*alopecurus protensis*), wood meadow grass (*poa nemoralis*), yellow oat (*avena flavescens*), Bokhara clover (*melilotus alba*), crimson clover (*trifolium incarnatum*), tall fescue (*festuca elatior*), hard fescue (*festuca duriuscula*), sheep's fescue (*festuca avina*), crested dogstail (*cynosurus cristatus*), alsike clover (*trifolium hybridum*), rescue grass (*bromus unioloides*, or *schraederi*), Japan clover (*lespedeza striata*), and a few others of more interest than value.

In addition to these separate grasses, we put in some mixtures, some of probable or undoubted value to our farmers, and others merely to study the social relations and struggle for existence when a large number of grasses are growing together. Some of the mixtures were as follows:

1. Orchard, tall meadow oat, English rye, sweet vernal grasses and red clover.

Probably the best and safest mixture for hay for our farmers to start on.

2. Henderson's mixture for permanent hay and pasture,

presented by Peter Henderson & Co., seedsmen, New York. Said to contain the following:

Orchard, meadow foxtail, sheep's fescue, creeping (Rhode Island) bent, hard fescue, sweet vernal, meadow fescue, English rye, Italian rye, red top.

3. Prof. Brown's mixture of Guelph, Canada (nearly):

Orchard, tall meadow oat, English rye, meadow fescue, meadow foxtail, Kentucky blue, red top and yellow oat grasses, and lucerne, red, white, alsike and yellow clovers.

4. This is nearly the composition of Lawes' and Gilbert's meadow land at Rothamstead, England.

Meadow foxtail, timothy, sweet vernal, red top, velvet, tall meadow oat, yellow oat, Kentucky blue, orchard, crested dogstail, creeping bent, sheep's fescue, meadow fescue, tall fescue, bromus mollis and English rye grasses, and white, red and trefoil clovers.

For sheep pasture, especially adapted to our sandy lands and hillsides:

Crested dogstail, hard fescue, sheep's fescue grasses, and white clover.

6. A common mixture for hay:

Orchard grass and red clover.

7. Another common mixture for hay, largely used at the north:

Timothy and red top grasses.

8. Mixture recommended by Capt. S. B. Alexander, of Mecklenburg county, for hay and pasture:

Bermuda grass and red clover.

9. Recommended by Dr. D. L. Phares:

Spotted medick and crab grass.

10. Flint's mixture for hay and pasture, presented by Henry A. Dreer, seedsman, Philadelphia, Pa.

Some samples of grass seed were also sent in by farmers to be studied in this connection. These were put in. The plots for these mixtures were on good soil, well prepared and fertilized, and were each 5 x 7 feet.

GENERAL CONSIDERATIONS ON THE HAY AND PASTURE GRASSES.*

The study of the more important grasses for hay and pasture lands, and of the artificial formation and treatment of natural or artificial, permanent and temporary meadows and pastures, and of the introduction of the same into the State, was early recognized as one of the most important questions the farm could take up, and the growing interest manifested in our work shows the importance attached to the subject by our farmers.

Although the subject is a good one in itself, and worthy of great effort, there is danger, as in all new undertakings, that the efforts, being wrongfully applied, may fail of the desired ends and bring disappointment and loss on the individual worker, and more or less discredit upon the subject. Therefore a few words of warning and a very brief survey of the subject and of the line of experimentation we intended to pursue may be in order.

We want, first, a grass, or mixture of grasses (and clovers), that will give us a *big* return for our outlay, either for soiling or hay. This will usually be only obtained from an annual or biennial plant and necessitates a reseeding every year or two. Second, a grass, or mixture of grasses (and clovers), that will furnish a *moderate* return for any outlay, in grazing or hay or both, which under proper treatment will stand by us in all seasons, and even improve from year to year, raising the value of our land, as it surely will, to $100 or $150 per acre. Let us decide which of these we want and work up to it.

We are pretty well acquainted, or think we are, with the management and relative merit of orchard grass and red

*The following remarks, as well as much of the preceding data on the subject of grasses, has appeared in substance in the Bulletins of the Department of Agriculture.

clover, timothy and red top, but with us they are nearly all better suited to alternate husbandry than for permanent occupation of the land, and as we have no system of rotation of crops, we are left every two or three years with a piece of land we should like to keep in grass, but are compelled to break up if we would get a proper return from our land for the money invested.

The question is often asked, "Which is the most valuable grass?" or "What would you advise me to put in?" This depends—

First, upon what the grass is intended for, whether for hay, pasture or lawn, and for what kind of stock.

Second, upon the soil; and

Third, upon the climate.

There is little doubt that, considering all conditions of soil and climate in this State, the most valuable grasses we have for hay or pasture are Bermuda, crab and Johnson grass, although there are many who will not hear of the introduction or encouragement of any of these. But in spite of the lack of encouragement, and in the face of every opposition from the cotton planter, these grasses have come to stay, and if *attended to*, will prove of great value when stock alone is considered. Like most of the grasses, they must have the best land on the farm and be well treated to be seen at their best. It is admitted and urged that on a cotton plantation or other farm where these grasses cannot or will not be confined to their respective fields, they must not be introduced; but when they are introduced and well cared for, they are permanent and yield large crops.

For such farms or farmers as do not want these grasses, there are other grasses and clovers which, if grown together and well treated, will form a pasture or meadow that will last for years. But here we come to the artificial formation of a permanent meadow or pasture, a subject of which we in this State know little or nothing. In the western part of our country there are large areas of natural pasture consisting

mainly of one or two grasses, and some of the famous ox-pastures of England are said to consist mainly of perennial (English) rye grass and white clover, but the English meadows and pastures generally contain at least ten or twenty of the valuable grasses and clovers.

In the artificial formation of a permanent meadow or pasture, there is great difference of opinion among writers in regard to what grasses to use. In practice and in the natural meadows timothy, orchard grass, English rye grass and the clovers have usually a prominent place, but there are writers who condemn the use of any of these in a mixture for the permanent occupation of the land. Indeed, the same difference of opinion exists in regard to others of the valuable grasses, depending probably upon the soil and climatic conditions which prevail. On ordinary pasture land all admit the great value of meadow fescue, meadow fox-tail, and generally of orchard grass, tall meadow oat, timothy, Kentucky blue, red top, yellow oat, sheep's fescue, crested dog-tail, English rye grass and red and white clover.

Land containing a mixture of all these grasses could be used for early grazing, then a crop of hay taken, and it would then afford grazing for the rest of the year for horses, cattle or sheep.

The crested dog-tail and sheep's fescue are chiefly valuable for grazing sheep, and these, with hard fescue and white clover, will make a good sheep pasture, and would perhaps be the best pasture for our sandy lands and gravelly hillsides. For hay alone we believe a mixture of promise would be orchard, tall meadow oat and English rye grasses and red clover, as they are all valuable grasses, and on the separate plots of the pure grasses on the Farm, they blossomed together and were cut at the same time, May 16 and 18. But we believe, after hearing the evidence of what has been written of late years, that this mixture would be better placed in a rotation of crops, where it would occupy the land some two or three years, and not in a permanent meadow,

although this might depend largely upon the soil and climate.

Of the other grasses grown on separate plots on the Farm, Italian rye was the earliest, yielding a cutting on April 27 of about two tons to the acre of hay, or a total of two and three-quarters tons per acre in the three cuttings.

Next in order of earliness came the orchard, tall meadow oat and English rye grasses and red clover, cut on the 16th and 18th of May, as above.

These should have been cut a few days earlier, but were saved for visitors to the Farmers' Institute to see. The meadow fescue was cut May 26, at least two weeks after the above were ready to cut. Timothy and red top June 14, fowl meadow July 21, and other grasses still later, as already recorded.

To enlarge the scope of this work, and practically to work for the introduction of well kept meadows and pastures in the State, by familiarizing the farmers with their care and value, it was suggested in a report to the Board of Agriculture at the December meeting, that efforts be made to get seedsmen to donate small packages of grass seeds for hay, pasture, &c., in quantity sufficient for one quarter acre plots. A limited number of farmers in different sections of the State would probably be willing to receive such seeds as suited their soil and needs, measure off and prepare a plot of land according to our directions and give good after-treatment to the grass. A statement would be required from time to time of the condition of the sod, how it stands the winters and summers, the yield in hay or the amount and kind of pasturage. The data to be tabulated and published in the Bulletins and Reports of the Station.

If assured that this work will be undertaken and carried on in good faith, the seedsmen will probably be glad to donate seeds for these experiments in whole or at a nominal charge. We will accumulate data as to the adaptability of the different grasses to the soils of the State, and work for the introduction of, and better care for, the finer grasses.

On Some Forage Crops.

This work was conducted on the same land as last year. The plots were one-twentieth of an acre area, and each was fertilized at the rate of one ton of compost and 400 pounds of an ammoniated superphosphate *per acre.* The seeds were drilled or dropped in rows three feet wide April 21 and 22, and the usual stand for each was obtained as far as possible with one replanting.

The stands were approximately as follows: Dhoura corn, 2 plants, 6 inches: pearl millet, 12 inches; millo maize, 2 plants, 12–18 inches; sorghum, 4–8 inches; teosinte, 2 plants, 18–24 inches; kaffir corn, 2 plants, 6 inches; fodder corn, 4–8 inches; German millet and Hungarian millet, each, 1–2 inches. The land was not perfectly uniform in character, the worst plots as regards fertility and exposure probably being those containing the teosinte and millo maize. The yields of *air-dry* forage are given in Table VII.

TABLE VII.—YIELD OF FORAGE CROPS, 1887.

NAME.	WHEN CUT.	YIELD, AIR-DRY.	
		Per Plot.	Per Acre.
		Lbs. Oz.	Pounds.
Dhoura Corn	August 4	400-14	
	Nov. 3	55-2	9,120
Pearl Millet	Aug. 10	270-4	
	Nov. 3	70-1	6,806
Millo Maize	Sept. 20	334-7	4,689
Sorghum Ea. Orange	Aug. 4	167-1	
	Nov. 3	61-12	4,576
Soja Bean	Oct. 7	220-12	4,415
Sorghum Ea. Amber	Aug. 10	184-13	
		33-3	4,360
Reana Luxurans (Teosinte)	Sept. 20	201-1	4,021
Kaffir Corn	Aug. 4	169-14	
	Nov. 3	18-10	3,770
Fodder Corn	Aug. 2	186-11	3,734
German Millet	Aug. 5	157-13	3,156
Cow Pea	Oct. 7	94-10	1,893
Buckwheat	June 13	89-0	1,780
Hungarian Millet	Aug. 5	68-7	1,369

We were much pleased with Dhoura corn for fodder or ensilage, the yield with us being over two and a half times greater than the fodder corn. The Pearl or Cat-tail millet (*Penicillaria spicata*), gave an abundant yield of forage, but it did not cure well. The true place for this is on a rich soil, well manured, cut often and fell green or in a wilted state. The yield under these conditions is said to be enormous, yielding a "product of 80 to 100 tons of green forage, or from 16 to 20 tons of dry hay"* per acre. We think a small plot of this grass, well cared for, would be very valuable for soiling cows.

The millo maize did not do so well for us this year as last. We look upon this, with the Dhoura, fodder corn and Pearl millet, as valuable forage plants. The fodder corn did not do so well as expected, nor as some on another part of the Farm. One reason was that the stand was not good and hardly close enough for this land, the corn growing too large and coarse for the best fodder. The Kaffir corn makes very good forage, hardly as good as the Dhoura, but is a much shorter plant than the latter, and although it tillers well, it could hardly be expected to yield more than half as much forage to the acre as the Dhoura. The Teosinte takes too long to mature, and is too slow a grower for us, still it deserves further trial.†

It was planned and expected that analyses would be made of these plants to determine their relative feeding value, but it has been impossible to complete the work at this time. This would be needed to show the relative value of the millets, cow peas, soja bean and buckwheat in the table.

Buckwheat is a very rapid grower, and we could easily have had three or four crops from the same land this season. The root system is very small and mainly within two or

*Farmer's Book of Grasses," &c., p. 109.

†The cow peas, Teosinte, soja bean and millo maize were injured while drying in the open air by a protracted rain during Fair week, when there was no house room for them.

three inches of the surface. Still the plant does well in hot weather.

We have tried Lupin and Vetch for two seasons with no success whatever.

Yield of Corn under High Manuring.

The results of the experiments ordered by the Board in January to determine the yield per acre of cotton and corn under high manuring, have already been partly discussed. It remains to note the data for corn. One-tenth acre of land was selected inside the race track on the Fair grounds. The soil is a heavy loam, containing much red clay, hardly a desirable soil for corn, but in better condition than any on the Farm lands proper. Compost was applied at the rate of four tons *per acre*, and an ammoniated superphosphate at 1,000 pounds *per acre* as with the cotton. Mosby's Prolific corn from the U. S. Department of Agriculture was planted, 4 x 4 feet apart, May 3. There was a tolerably good stand after one replanting. Following is a summary of the yield, and as a matter of interest, the detailed weight of the entire *air-dry* product *per acre* is given:

Shelled corn	1,618 pounds.	28.9 bushels.
Stalks	983 "	
"Top" fodder	610 "	
Shucks	574 "	
"Blade" fodder	461 "	
Cob	254 "	
Total air-dry product *per acre*	4,500 "	

Unfortunately for lack of other data, no comparison can be made with the yield on unmanured land adjacent to this.

The average yield of shelled corn for the State, as given in the census, 1880, is 12.2 bushels, and for Wake county 11.5 bushels. As in the case of cotton, so in this experiment it would seem that the limiting cause was other than a lack of available plant food.

Vineyard and Fruit Trees.

At the suggestion of the State Horticultural Society, we set out a vineyard of 290 vines, covering nearly half an acre, and containing 121 varieties of grapes. The collection was purchased of Bush & Son & Meissner, Bushberg, Jefferson county, Mo., and comprises the following varieties, the figures indicating the number of vines of each.

2 Agawam (Rogers' No. 15), 2 Bacchus, 2 Black Eagle, 2 Black Pearl (Schraidts), 4 Brighton, 4 Catawba, 4 Champion, 4 Clinton, 4 Concord, 4 Cottage, 2 Cunningham, 2 Cynthiana, 4 Delaware. 2 Diana, 4 Duchess, 2 Elvira (Rommel's), 2 Etta (Rommel's), 2 Eumelau, 2 Gœthe (Rogers' No. 1), 2 Grein's Golden, 2 Hartford Prolific, 2 Herbemont, 2 Herbert (Rogers', No. 44), 2 Hermann, 2 Isabella, 4 Ives, 4 Lady (Campbell's), 2 Lindley (Rogers' No. 9), 2 Louisiana, 4 Martha, 2 Massasoit (Rogers' No. 3), 2 Missouri Reisling (Grein's), 2 Merrimack (Rogers' No. 19), 4 Moore's Early, 2 Montifiore (Rommel's), 2 Noah (Wasserzieher's), 4 Norton's Va., 4 Perkins, 4 Prentiss, 4 Pocklington, 4 Salem (Rogers' No. 53), 2 Taylor's Bullit, 4 Telegraph, 2 Triumph, 2 Wilder (Rogers' No. 4), 4 Worden's Seedling, 2 Advance (Rickett's), 2 Alvey, 2 Amanda, 2 Amber (Rommel's), 2 Arminia (Rogers' No. 39), 2 Black Defiance, 2 Brant (Arnold's No. 8), 2 Bottsi, 2 Cambridge, 2 Canada (Arnold's No. 16), 2 Cassady, 2 Challenge, 2 Conqueror, 2 Cornucopia (Arnold's No. 2), 2 Creveling, 2 Croton, 2 Devereux or Black July, 2 Dracut Amber, 2 Elsinburg, 2 Eva, 2 Faith (Rommel's), 2 Humboldt (Muench's), 2 Imperial (Rickett's), 2 Janesville, 2 Lenoir, 2 Marion, 2 Maxatawney, 2 Miles, 2 Neosho (Muench's), 2 New Haven, 2 Northern Muscadine, 2 North Carolina, 2 Oriental, 2 Othello (Arnold's No. 1), 2 Pauline, 2 Peter Wylie, 2 Rentz, 2 Regna (Rogers' No. 28), 2 Rogers' No. 2, 2 Secretary (Rickett's), 2 Transparent (Rommel's), 2 Uhland (Weydemeir's), 2 Venango, 2 Waverly (Rickett's), 2 Whitehall, 2 Welding (Rommel's), 2 Wyoming Red, 2 Amber Queen, 2 Beauty (Rommel's), 2 Centennial (Marwin's), 4 Early Victor, 2 Eldorado (Rickett's), 4 Empire State (Rickett's), 4 F. B. Hayes (Moore's), 2 Highland

(Rickett's), 2 Jefferson (Rickett's), 2 Jessica, 2 Lady Washington (Rickett's), 2 Mason's Seedling, 2 Naomi (Rickett's), 2 Niagara, 2 Norfolk, 2 Pearl, (Rommel's), 2 Rochester, 4 Vergennes, 2 Woodruff Red.

This is believed to be a very fine collection of grapes, and considering the importance and growing interest in this work, the study, as proposed, would doubtless prove of interest and value if it could be continued.

There was likewise set out at the suggestion of the Society, a number of varieties of fruit trees, in duplicate, including 27 varieties of apples, 25 of peaches, 19 of standard pears, 8 varieties of dwarf pears, besides quince, plum, cherry, apricot and nut trees. These were intended for observation and future experimental work. A committee, composed of Messrs. S. O. Wilson and P. W. Johnson, visited the Farm May 13, on behalf of the State Horticultural Society, to inspect the work under way, and advise about the management of the vines and trees.

Miscellaneous Farm Work.

Other miscellaneous work was done on the Farm, which needs no special mention here, such as the corn, oat and forage crops for the farm stock; some garden work planned and partially carried out in the spring; a small meadow set in Ozier willows and another set in cranberries. Also some experiments with wheat, cow peas and turnips, which were of local interest only, or remain yet unfinished.

STUDY OF SOME PHYSICAL PROPERTIES OF THE SOIL AND OF METEOROLOGY IN THEIR RELATION TO PLANT-GROWTH.

The general meteorological conditions of plant growth are so complex and so interdependent that a study of one must necessarily include a study of most if not all of the others, to a more or less considerable extent; so while we have continued the study of the temperature of the soil as our principal work, we present with these results a very complete record of other important data, necessary alike for the abstract study and for its practical application to the study of plant-growth and to agriculture.

The practical importance and value of this work was referred to at some length in the last Annual Report, but it will be well to refer to it briefly again. The soils of this State are very characteristic, and are generally very sharply defined. The sand, gray and yellow sandy and gravelly loams and red clay soils, with the gray or yellow sandy, or gravelly loam, or the yellow, red or pipe-clay subsoil, composing the agricultural "regions" of the State, are so well defined that it is no unusual thing to see a farm road separate a field that will produce several hundred dollars' worth of bright tobacco per acre from a field not suited to tobacco, and which, under the same treatment, will hardly pay for the production of an ordinary farm crop. Chemical analysis has not explained this, nor have field experiments with fertilizers. As the meteorological conditions are practically the same over both fields, it remains to examine the physical condition and properties of the soils as related to plant-growth. An illustration of this was seen on the farm of

Mr. Fielding R. Knott, in Granville county, where we made some observations on the temperature of some of the finest and most valuable bright tobacco lands in the State, as given in the last report.*

The illustration was carried even further, for on this farm there are two fields which we will call "East Lot" and "West Lot," with apparently the same gray sandy soil, exposure and conditions in each. In favorable seasons as much as five and six hundred dollars' worth of tobacco have been raised on this land, and there is little choice between the fields. A good crop on East lot was nearly always assured, but on West lot the crop is often lost or seriously injured in unfavorable seasons (excessive rain, or sudden change from wet to dry, or the reverse), by the black rot, flea bugs, &c. Remedies might be applied to stay the ravages of disease and insects, but obviously here is a case where we might go farther and by finding how one soil differed from the other, only a couple of hundred feet away, we should expect to determine the primary cause of this difference. An examination showed the soil and subsoil of West lot to be much finer than the corresponding depth of the other field, so fine and compact indeed that it was with difficulty the 6-inch iron sampler was driven down. At our request a mechanical analysis of several samples from both of these fields was made at the Conn. Experiment Station by their "Beaker Elutriation" method.† The results of this analysis, as given in Table VIII, make it appear that the soil of West lot is really considerably finer than that in the other field, and at least suggest the poorer drainage of the West lot as the primary cause of the disease and insect ravages in unfavorable seasons. In the table, "^{mm}" stands for a unit of size for the grains of sand (1 millimeter or about one twenty-fifth of an inch) and the figures 1, 2, 3, at the

*Report 1886, page 93.

†Report Conn. Agr'l Experiment Station, 1886, pp. 141—158.

head of the column as respectively the first, second and third six inches in depth of soil taken one under the other.

TABLE VIII.

RESULT OF MECHANICAL ANALYSIS OF GRANVILLE COUNTY, N. C., TOBACCO SOILS, BY DR. T. B. OSBORNE, OF THE CONNECTICUT EXPERIMENT STATION.

Reported by Prof. Johnson, June 15, 1887.

SIZE OF PARTICLES OF THE SOIL. (1 mm—about 1-25 inch.)	EAST LOT. Depth of Sample, inches.			WEST LOT. Depth of Sample, inches.		
	1 0-6	2 6-12	3 12-18	1 0-6	2 6-12	3 12-18
2 mm—1 mm	4.75	4.98	5.43	1.09	0.99	1.44
1 mm—0.5 mm	15.56	14.86	13.02	5.01	4.09	3.71
.5 mm—0.25 mm	26.88	26.83	24.14	19.31	15.62	13.86
.25 mm—0.05 mm	31.08	27.55	29.83	41.59	37.80	37.07
.05 mm—0.01 mm	12.65	13.39	13.56	21.58	25.85	26.87
.01 mm—0.* mm	6.14	10.04	11.83	8.43	11.99	13.28
Clay	.74	.63	.55	.63	1.27	1.21
Loss on ignition	1.97	1.17	1.21	1.71	1.16	1.84
	99.77	99.45	99.57	99.35	98.77	99.28

OR PRESENTED IN ANOTHER WAY.

	EAST LOT. Depth of Sample, inches.			WEST LOT. Depth of Sample, inches.		
	1 0-6	2 6-12	3 12-18	1 0-6	2 6-12	3 12-18
Coarser than 1 mm	4.75	4.98	5.43	1.09	0 99	1.44
" " .5 mm	20.31	19.84	18.45	6.10	5.08	5.15
" " .25 mm	47.19	46.67	42.59	25.41	20.70	19.01
" " .05 mm	78.27	74.22	72.42	67.00	58.50	56.08
" " .01 mm	90.92	87.61	85.98	88.58	84.35	82.95
" " 0* mm	97.06	97.65	97.81	97.01	96.34	96.23
"Clay,"	.74	.63	.55	.63	1.27	1.21
Loss on ignition	1.97	1.17	1.21	1.71	1.16	1.84
	99.77	99.45	99.57	99.35	98.77	99.28

*Exclusive of "clay."

It is impossible to tell without further investigation and experimentation the value of these suggestions, but from the

importance of the subject they seem worthy of further attention, and in so far as they go, show the importance of the study of the relation of the physical properties of the soil to plant-growth.

The mechanical analysis of the heavy loam just across the road from these fields, where bright tobacco cannot be grown, would give results of considerable comparative interest in connection with those in the table. A difference of five degrees in temperature has already been reported between this tobacco soil, three inches deep, and our cotton soil on the Farm at the same depth, as a mean of three observations taken at intervals of six hours July 28, 1886. Other very important differences in the physical properties of soils having different productive capacities will appear in this report suggesting a line of investigation, promising results of practical value to our farmers whenever a further and more elaborate study of the physical properties of the soils in the field, greenhouse and laboratory can be carried on.

Our work has been confined to a study of the soils on the Experiment Farm, and their relation to the development of the cotton plant. The practical object in the application of the work has been to determine the causes which control the production and quality of the cotton and the time of ripening. Such work is, perhaps, even more needed in the case of the yield and quality of the several well marked grades of tobacco, in the vineyards, and other staple crops of the State, and it was our purpose to include the study of the bright and heavy grades of tobacco in our work this year had circumstances permitted.

CONDITIONS OF GROWTH OF THE COTTON PLANT.

The cotton plant is peculiarly sensitive to the conditions of heat and moisture. Mr. James F. Naury, Sec. Committee of Information and Statistics of the New York Cotton Ex-

change, in a letter to the Chief Signal Officer,* Washington, writes of the information they desire from the cotton belt to post themselves on the condition and prospects of the cotton crop. He says:

"'The most important thing for the crop is the rainfall. * * If to this is added the maximum and minimum thermometer readings for the twenty-four hours, there is nothing more to be desired, and any planter, factor, or dealer who will study these three records, can get a good idea of the crop prospects.'"

The conditions of plant-growth are about as follows: The cotton is planted as early as possible and at about the lowest temperature at which germination will take place, but yet when all danger of frost is over. In this section this will be after the middle of April. From this on, to the middle of July, the temperature will rapidly rise and the rainfall increase, conditions which favor the growth of the plant or the production of "weed." If these conditions continue unchanged, the plant will become perennial and continue to grow from year to year, assuming even the form and size of a tree or shrub, as seen in the hot countries of India and Africa. With us July marks a turning point in the life of the plant. The temperature begins to fall as rapidly as it had before risen and the rainfall to grow less, conditions which practically stop the growth of the plant ("weed") and favor the production and ripening of the fruit.

The average mean temperature and rainfall for a period of years of ten places in the South Atlantic, and six places in the Eastern Gulf States for the four seasons of the year (March, April, May, as spring, &c.), is calculated from the report of the Chief Signal Officer (1885, Pt. 1, p. 151):

*Report C. S. O., 1886, p. 149.

	Temperature. Degrees.	Rainfall. Inches.
Spring	63.5	14.67
Summer	79.3	16.96
Autumn	65.9	13.53
Winter	50.0	13.94

An inspection of diagram I will show this distribution of temperature at the Farm for the growing season more in detail. This of course supposes a normal amount of sunshine, humidity, wind and an absence of any unusual phenomena.

REVIEW OF THE WEATHER AND CONDITION OF THE CROPS, SEASON OF 1887.

The weather and crop prospects up to the first of August were unusually fine—better than for some years past, but the unusually large rainfall following this, very materially lowered the actual yield below what had been expected.

The following is extracted from the monthly crop reports, from statistics and information furnished by the farmers and compiled and published in THE BULLETIN by the Secretary of the State Board of Agriculture:

JUNE.—"The crops in North Carolina are in fine condition. From all parts of the State the good news is pouring in. In some sections the farmers say that the stand is better than it has been for many years, and in all sections the returns show a large increase over the yield of the last few years." *Cotton*—"The report is almost universal in declaring the stand of cotton to be far above the average. With propitious seasons and with better work, because of smaller area seeded, the cotton crop has a fine start in the State. The general condition of the crop is rarely better than we find it in all parts of the State on the 1st of June. It is too far from "picking" time to undertake to forecast the yield, but it is perfectly safe to say that if no very unfavorable contingencies arise, either in seasons or from insects, that the yield will be greater to the acre than for several years past." *Corn*—"The corn crop bids fair to be the largest raised for many years. The spring weather was favorable to seeding, and was cool enough to retard vegetation, while it af-

forded pleasant weather for the work of preparation. It also prevented damage to crops by late frosts. This weather was followed by a warm sun and the usual showers, favoring the rapid germination and growth of corn and cotton. * * The season has been all that could be desired, and unless some unexpected calamity should befall the crop the yield will be greatly in excess of the average crop in this State." *Wheat*—"The wheat crop is reported exceptionally good in most all sections of the State. There was some little damage in some sections because of the drought last fall, but in many instances this was recovered by the exceptionally fine seasons of the spring."

JULY 15.—*Cotton*—"The condition of the cotton crop, in comparison with the last report, is altogether favorable in the entire State, while there are a few isolated reports which are unfavorable. In the cotton belt of the State good stands are reported, and the crops are said to be clearer of grass and weeds than for many years. In middle North Carolina the grade is 100; in Eastern North Carolina 102; in Western North Carolina 98; in the State at large 100. With a continuation of the favorable seasons the crop will improve on the figures given above, while if no more rain falls the crop will still be a very fair one. Some heavy rains have fallen, but no appreciable damage is reported from this cause." *Corn*—"The condition of the corn crop in the entire State is above the average and may be graded as 105, as the crop will be in excess of the normal yield, both as to acreage and average production to the acre. There has been considerable complaint in some sections of the State of the ravages of the chinch bug. The farmers, where the pest was threatening crop, promptly applied the kerosene emulsion—directions for making and applying found in this BULLETIN—and with general success. The damage from this cause will not reduce the average in the State. The crop is practically "laid by," as the farmers say, and unless damaged by drought, will harvest more than a normal yield." *Wheat*—"The wheat crop harvested this year is in many respects the most remarkable that has been raised in this State for many years. The whole State will grade 95, and in some sections it will go as high as 110."

AUGUST 10.—"The atmospheric condition for all growing crops was entirely favorable up to the first of August. There were occasional complaints of continued dry and hot weather, but since that time much rain has fallen. Corn has been damaged to considerable extent along the water courses, and cotton has not escaped entirely. It is impossible to rate the per centage of damage correctly at this time, as many of the reports were mailed the first week in August. Due allowance must be made for the calculations made from imperfect data." *Cotton*—"The crop is still in good condition, though somewhat washed by the heavy rains. Some complaint of rust in parts of the State, but this is not general, nor will it affect the crop. If there is not continued rainfall from

this date, the average crop of the entire State will not grade below 97, which is three points below the July report. The cotton belt is up to 100, but the border counties reduce the average." *Corn*—"The crop on uplands is prime, 100 to 105; in low grounds flooded and damaged as much as 20 per cent. in the State at large. This reduces the July estimate for the State from 105 to 90. Complaints from damage by chinch bug disappeared from the August reports. Notwithstanding the loss from excessive rain, the corn crop of the State will be largely in excess of the normal yield for the last few years. The greatest loss probably occurs in the valley of the Yadkin and its affluents, and in the Catawba valley." *Wheat*—"The wheat crop has been threshed and the late reports show a reduction over former estimates in some localities, while others run up to 110. The average for the State will come down three points from the July returns, making the general grade 92."

SEPTEMBER 15.—"There has been unusual rainfall since the August report was published, and there has been in addition, a phenomenally cool period for the time of year. These unfavorable atmospheric conditions have tended to the damage of growing crops. Cotton is susceptible to cold and has, in consequence, been the greatest sufferer. Corn was but slightly affected by the cool weather, but suffered in the low lands from excessive moisture; in many instances crops were completely submerged by the floods. The second hay crop has had fine growing weather; the same may be said of peas and the green fertilizing crops." *Cotton*—"There is complaint of shedding bolls, and of the leaves of the plant turning red, and in some sections red rust has made its appearance. Where this is the case the plant ceases to grow, and but few of the later bolls develop. Notwithstanding these unfavorable conditions, the average for the State is only reduced to 85⅞ against 97 for August. The majority of the damage occurred on the northern border of the cotton belt, and east of Raleigh." *Corn*—"The condition of this crop is still excellent in the State, and considering the acreage planted, will still be an enormous crop. The excessive rains have damaged late corn. In parts of the State more than half of the crop was swept away by floods. These were exceptions, only occurring in limited areas, and were confined to bottoms, which were subject to overflow. Taking into consideration all these misfortunes to the crop, it is reported even larger than in August. The grade of the State has increased from 90 in last report to 95⅛ for the current month." *Wheat*—"Now that the crop has been threshed, and the actual production ascertained, there is a reported increase of more than two points since last month. The average grade of the State is now set down at 94½ as against 92 on August 10th." A valued correspondent at Elizabeth City states that: "Cabbage have been a complete failure, owing to excess of rain."

OCTOBER 15.—*Cotton*—"Notwithstanding the complaints from unfavorable atmospheric conditions in September, the returns show an in-

crease in the yield in cotton of more than four points since the 15th of last month. The average production in the State grades 89¼." *Corn*—The same improvement is noted in the production of corn. The conditions have been unusually favorable for the maturing of this crop. The average for the State at large, compiled from the October reports, shows 96⅜ to be a fair estimate. Nearly all the crop has been housed."

NOVEMBER 18.—*Cotton*—"It was ascertained that the average estimated yield of lint cotton, per acre, in the State at large, was 375 pounds. Also, that there is now in the fields 22 per cent. of the crop unpicked." *Tobacco*—"Special enquiry was made as to the estimated average yield of tobacco, in pounds, per acre. It was found that the average of the counties growing tobacco is 493½ pounds to the acre. Enquiry as to the average price realized for this product in the same counties gives as the result 10⅝ cents to the pound. This estimate may be a fraction large, as some of the correspondents left the question unanswered, but that is the average of those reporting."

These extracts, forming the body of the monthly crop reports, will serve to recall the leading features of the past growing season, and are considered of value, if not a necessary adjunct of the work which follows.

ON THE MOISTURE IN THE SOIL.

A most important subject in connection with the study of the temperature of the soil and of the relation of the soil to heat, as well in the abstract study as in the relation to plant development, is the amount of moisture in the soil.

Every farmer can tell at a glance whether the weather is favorable for his crops, and whether his soil needs rain, without looking at the table of rainfall and temperature, published by the Signal Service. His meteorological instruments will probably be his foot with which he will knock the soil away and tell you that for such hot weather the soil is too dry for the growth of plants unless it is in the fall and the crops are ripening, when they will wish a dry soil, as a wet one will cause their crops to keep on growing, or "run to weed." Generally, the farmers want plenty of *moisture* in the *soil* until the middle of July. Their crop production is

not directly limited by the amount of rainfall, but by the moisture in the soil.

Six inches of rainfall a month, with a certain temperature, may mean a good season, or if the rain all came at once, followed by a succession of bright days, it might mean serious harm to the crops. In a greenhouse, the amount of water given to a plant depends upon the temperature and upon the general appearance of the soil and plant. It would be hard to tell by looking over the meteorological data which had been the most favorable year in the past fifteen years for a large crop production. The oasis in the desert owes its luxuriant growth of vegetation to springs that come near the surface, as there is seldom or never rain.

Boussingault states that in one town in South America the inhabitants assured him they had had no rain in seventeen years. So, while we admit it is very important to know the rainfall, still as the rain does not do the former any good until it enters the soil, it is very essential that the rainfall be studied below, as well as above, the surface of the ground.

We find, generally speaking, that good growing weather for cotton (for the production of "weed"), is a rather high air temperature, and 8 or 10 per cent. of moisture in the "fine earth," or about 170,000 to 200,000 pounds of water per acre in the top six inches of soil. It may be stated generally that with a high air temperature, the more moisture a soil contains within reasonable limits, the more favorable are the conditions for the production of "weed," while with less moisture and a lower temperature, the conditions are more favorable for the production of fruit It must be remembered, however, that for good fruit production, it is necessary to have well developed plants, or sufficient "weed," and so the conditions favoring a good cotton crop will probably consist of a period favoring the production of "weed" for the perfect development of the plant with later, a dryer soil, favoring the production and early ripening of the fruit.

This accords with the conditions actually existing in the principal cotton States, as shown on page 166.

The moisture determinations in the soil have been made in the same place as last year, and in the same way. The results, however, are calculated differently, and for the sake of comparison, last year's results have been recalculated, and are given here in pounds, per acre, of water.

The average weight of our sampler* full of soil was found for twenty samples, each, representing the 1st, 2d, 3d and 4th, 6 inches in depth of soil (2 feet deep in all, and 80 samples in all). Stones larger than one-fifth inch were sifted out, and from the remainder the weight per acre of air-dry "fine earth" was calculated.† These weights for the different layers of our soil (a sandy loam with clay subsoil beginning 8 inches below surface) are as follows:

Top 6 inches	1,809,084	pounds per acre.
Second 6 inches	2,051,956	" " "
Third 6 inches	2,033,273	" " "
Fourth 6 inches	1,880,699	" " "

After taking a sample of soil, the per cent. of moisture in the "fine earth" is determined and calculated in pounds per acre on the above basis.

The soil is under cultivation (in cotton), hence the comparatively small weight of surface soil per acre.

*The same 5-inch wrought iron pipe, 6 inches long, was used as a sampler as was used last year.

†For the average amount of moisture retained in these air-dry soils, see Report 1886, p. 101.

WEEKLY DETERMINATIONS OF MOISTURE IN THE COTTON FIELD.

DATE.	Sample.	PER CENT. OF MOISTURE IN 'FINE EARTH'				POUNDS PER ACRE OF WATER, 1887.				RAIN IN WEEK	POUNDS PER ACRE OF WATER, 1886.				RAIN 1886.	CONDITION OF SURFACE SOIL, 1887.
		0-6 inch	6-12 inch	12-18 inch	18-24 inch	0-6 inches	6-12 inches	12-18 inches	18-24 inches	Inch	0-6 inches	6-12 inches	12-18 inches	18-24 inches	Inch	
Ap'l 22	XXXVI	8.38	11.69	13.69	16.11	165,467	271,616	322,506	361,164	0.43	.....	.....	.....	.....	0.0	Good.
29	XXXVII	18.45	13.74	17.11	19.64	409,290	326,847	419,704	459,643	1.42	.....	.....	.....	.....	2.2	Very wet, high winds.
May 5	XXXVIII	7.71	11.88	17.05	19.68	151,132	276,637	417,930	460,808	0.00	.....	.....	.....	.....	1.1	Good growing weather.
13	XLI	11.98	12.02	15.02	18.61	246,226	279,277	359,375	430,025	1.11	.....	.....	.....	.....	0 6	Rather wet to work.
19	XLIII	10.40	11.29	14.66	16.04	209,982	261,172	349,282	359,295	0.00	.....	.....	.....	.....	0.6	Dry for such high temp.
27	XLIV	13.67	13.57	14.74	18.69	286,461	322,168	351,518	432,298	1.70	179,795	247,154	311,368	375,959	0.5	Too wet to work.
June 4	XLV	14.42	14.69	15.01	19.21	304,825	353,337	359,094	447,186	1.79	326,788	331,545	367,000	423,232	1.2	Too wet to work.
11	XLVII	14.25	12.97	14.29	20.02	300,634	305,801	338,997	470,762	1.83	329,142	311,504	417,635	441,152	1.6	Too wet to work.
18	XLVIII	11.55	11.48	15.75	19.94	236,234	266,114	380,107	468,412	0.00	254,667	346,309	353,197	406,121	0.9	High temperature. fine growing weather.
25	XLIX	10.20	13.74	13.18	....	205,486	326,847	308,668	....	3.25	233,002	309,328	297,011	375,147	0.8	Too wet to work.*
July 2	L	10.58	11.74	14.10	18.51	214,047	272,943	333,750	427,190	0.00	437,109	363,775	390,752	486,449	2.45	Fine condition.
9	LI	16.62	14.66	17.19	21.22	360,601	352,492	422,074	506,580	3.03	326,788	358,706	456,652	431,434	2.7	Too wet to work
16	LII	10.55	11.77	16.55	21.47	213,369	273,733	403,248	514,180	0.00	230,700	303,636	398,871	435,148	0.35	Fine condition.
25	LV	12.22	13.84	18.94	21.66	251,836	329,608	475,0 2	519,989	1.87	155,067	215,640	195,948	255,973	0.0	Rather wet to work**
30	LVI	15.11	13.80	18.19	20.46	322,008	328,504	451,964	483,770	1.02	150,273	205,173	282,791	362,233	0.0	Too wet, show'rs and fog
Aug 6	LVIII	12.68	15.48	20.04	22.77	262,702	375,819	509,589	554,493	3.40	267,570	270,463	317,828	369,897	0.4	Very wet from showers.
13	LIX	10.06	13.00	20.41	23.34	202,350	306,614	521,411	572,599	0.24	332,061	330,185	332,930	430,625	2.3	Good condition.
20	LX	11.73	11.89	15.84	20.25	240,405	276,901	382,688	477,541	2.22	340,979	337,735	439,330	469,271	2.0	Heavy from much rain.
27	....	....	....	....	....	satura	ted.	.....	.....	4.34	207,195	332,93	464,044	505,845	1.0	So wet no sample taken.
Sept. 3	LXI	10.10	13.00	16.89	21.13	203,245	306,614	413,211	502,869	0.79	114,575	249,184	445,510	494,805	0.2	Fair conditi'n, wet below
10	LXIII	5.20	9.04	16.11	19.34	99,232	203,932	390,464	450,938	0.00	200,334	324,693	475,027	500,325	0 0	Dry.†
17	LXIV.	5.58	7.69	16.70	20.85	106,912	170,940	407,630	495,421	0.40	117,320	333,618	476,401	515,508	0.0	Dry.†
24	LXV	8.36	7.84	14.49	19.42	165,036	174,558	344,545	453,253	0.39	.....	.....	.....	.....	0.0	Good for time of year.
Oct. 1	LXVI	10.65	9.29	13.89	16.63	215,632	210,149	327,978	375,147	1.53	.....	.....	.....	.....	0.0	Too wet for cotton.
8	LXVII	6.26	7.03	11.70	....	120,811	155,160	269,414	.....	0.00	89,744	299,304	453,425	435,716	0.0	Dry.†
15	LXVIII	4.00	5.53	8.09	20.31	75,378	120,115	178,970	479,320	0.10	89,974	206,912	387,869	505,066	0.0	Very dry.†

NOTE.—Land unmanured for several years. Cotton planted April 20. First appeared above ground May 4. The spring and summer were excellent for grass. *The first of the week the weather was extremely hot, injuring nearly all crops but cotton. **Extremely hot spell first of week. Maximum temperature 18th, 101.5°. The soil was in good condition for a more moderate heat. After this there was a succession of heavy thunder showers. †Good condition for the ripening crop.

It is interesting to compare corresponding periods of the two years. Take for instance, the month of June, as in the following table:

TABLE IX.

CONDITIONS IN 1887 COMPARED WITH 1886.

Week ending	Temperature of Soil.	Moisture in Surface of Soil.	Rain.
June 4	Lower.	Less.	More.
11	Higher.	Less.	More.
18	Lower.	Less.	Less.
25	Higher.	-----	More.
July 2	Higher.	Less.	Less.

It will be remembered June, 1886, was considered an unusually wet month. There was recorded 4.8 inches of rainfall against 6.22 inches this year. Yet we have found less moisture in the soil this year than for the corresponding periods of the month of last year, save for one period which could not be compared. This will help to illustrate our position in regard to the insufficiency of the data furnished only by the rainfall and air temperature records of the Signal Service.

Our records are confessedly incomplete. The moisture is simply what is found in the soil at the end of a period of seven days, and does not represent the mean amount in the soil, so the results will depend largely upon the distribution of the rainfall. Still, until our methods can be improved, the data we are collecting are of value. Why is it that with 1.42 inches more rainfall this June than last, the month has not been so "wet" this year as last? Our other records show there has been much more sunshine, or 71.30 per cent. of possible sunshine in June, 1887, against 47.92 per cent. for the same period in 1886. The difference of 23.38 per cent. (almost half as much as was recorded last year), must represent a great deal of evaporating power from the sun.

Besides this, we find the mean temperature of the soil notably higher for June, 1887, than for 1886, and this would show conditions favorable for evaporation, and probably in this case more favorable for plant-growth.

A further discussion of these results, as well as moisture determinations in other soils and under different conditions, will appear in other parts of this report.

On the Temperature of the Soil.

THERMOMETERS.

The soil thermometers were the same as used last year, except the 48-inch, which was added to the set, and the 24-inch and 12-inch (after 7 P. M. June 18), which were replaced by new ones made by the same maker (Green of New York). There are two objections to urge against this form of instruments. When the stem is over 18 or 20 inches long, the scale is largely made by calculation, and it is difficult or impossible at present to obtain corrections for the instruments, as comparators are not made long enough to receive them. We have found it impossible to obtain satisfactory readings of these long thermometers, even in a well ventilated instrument shelter. This leaves some doubt as to the accuracy of the actual readings, but we believe the comparative readings of the instruments are nearly right, as we have tested them in many ways.* Another source of error, both in the absolute and comparative reading, in the long instruments, where the bulb is over 20 inches below the surface of the ground, the stem is frequently made in

*The surface thermometers and the 3-inch of the duplicate set were compared for a long time with our exposed thermometers, and the scale of correction there determined has been applied in every instance where they are used in this report. The temperatures and differences in temperatures are all given in degrees Fahrenheit.

two pieces, joined by fusion just below the surface of the ground to allow that part of the stem below the scale to contain a smaller bore so that the capacity of the stem shall bear as small a proportion as possible to the capacity of the bulb. Where the stem is joined an enlargement of the bore is necessarily produced, forming a bulb of a secondary thermometer at a point just at or below the point of greatest variation in temperature.* The effect due to this cause will probably fall within a few tenths of a degree, but to this can probably be traced the apparent greater hourly variation in temperature at a depth of 48 inches in the soil, than at 24 inches, as appears from our records. Considering the complex nature of the subject, it is doubtful if either of these sources of error have any practical value in our results.

The instruments were read at 7 A. M., 1 P. M. and 7 P. M. to compare with last year, it having been impossible at that time to take the readings at intervals of 8 hours, as done by the Signal Service. Each of these instruments reaches the maximum and minimum at different times, mainly depending upon the depth in the soil, so it is not probable that a mean of the three readings will give the true mean temperature of the day in all cases, consequently this has rarely been computed.

SOIL.

The principal set of soil thermometers, from which a continuous record of the tri-daily observations during the growing season is given, was in the same position as last year, in a loam resting on a red, underlying a yellow clay subsoil, naturally well drained by strata of broken quartz rock. From the growth of the plant on this continuously unma-

*The surface of the soil is sometimes 60 degrees hotter at 1 P. M. than at 7 A. M. The glass is also liable to break at this point from this cause. We have lost three instruments in this way.

nured land, this may be taken as a typical cotton soil. The thermometers were put in a cotton row in amongst the growing crop, and the soil around them was worked precisely as though they themselves were cotton plants, except that the adjacent plants were never allowed to shade them.

The duplicate set of instruments were placed from time to time in adjacent soils of different character or treatment, as will appear in the discussion of the results.

MEAN WEEKLY TEMPERATURE OF A COTTON SOIL.

The temperature varies so from causes of unknown value that a comparison from observation to observation, or from day to day, is almost hopelessly intricate, but over a considerable period, as a week for example, the variations are usually the mean or resultant of these causes and the comparison is rendered much simpler.

The following table gives the mean weekly temperature of the air and soil, and will be found more generally useful than the large table at the end of the report, where the readings are given in detail.

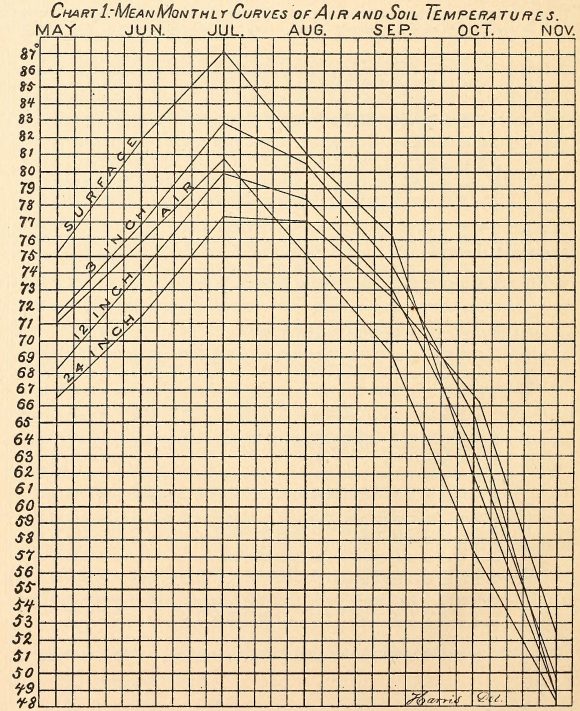
It is obvious, however, that the temperature might suddenly fall so low for one or two days as to seriously injure or destroy the cotton crop, and yet the mean temperature of the week hardly be lowered, so it is important to use this table, in connection with others in the back of the report, especially those showing the highest and lowest daily temperature for the period under consideration. This table will be found very interesting in connection with the moisture determinations and crop reports already given, and with the rain and sunshine tables to follow. The data is much more clearly presented graphically, in the form of "curves," some of which will be found at the end of this report, where the temperature of the soil this year is graphically compared with that of last year.

TABLE X.—MEAN WEEKLY TEMPERATURE OF THE AIR AND SOIL, 1887.

WEEK ENDING.		7 A. M.							1 P. M.							7 P. M.						
		Air.	Sur	3 in	6 in	12 in	24 in	48 in	Air	Sur	3 in	6 in	12 in	24 in	48 in	Air	Sur	3 in	6 in	12 in	24 in	48 in
May	7	62.2	65.7	61.1	62.2	63.5	...	...	80.2	95.2	78.3	69.6	64.1	...	...	75.5	70.3	74.0	72.7	67.6	...	...
	14	63.4	65.6	65.0	65.2	66.6	64.7	58.0	72.9	85.5	74.3	70.7	67.2	64.7	58.2	70.5	67.4	71.6	72.1	69.4	64.6	58.3
	21	61.9	62.4	62.9	63.9	67.0	66.0	59 9	80.5	97.8	79.9	74.1	68.0	66.1	60.3	77.2	73.4	77.6	77.6	72.3	66.0	61.0
	28	63.6	65.9	65.5	66.4	69.1	68.6	61.9	76.0	87.5	76.8	73.4	69.8	68.4	62.2	72.0	69.9	73.7	74.6	72.1	68.0	62.2
June	4	64.1	67.6	65.0	65.6	67.7	67.5	62.8	76.3	88.1	76.6	72.7	68.8	67.5	63.0	73.4	70.8	73.9	73.9	71.2	67.2	63.0
	11	68.9	71.0	69.9	70.4	72.3	70.6	64.0	81.7	94.0	81.6	77.9	73.3	70.5	64.3	74.8	73.5	77.5	78.2	75.6	70.5	64.3
	18	65.0	67.5	65.2	66.3	70.0	70.1	65.1	83.5	105.4	83.2	78.7	71.5	70.1	65.5	80.2	76.5	81.3	81.7	76.1	69.9	65.4
	25	71.8	76.0	74.6	75.4	77.6	75.4	67.2	85.0	105.3	85.9	82.9	78.1	75 3	67.5	82.1	80.6	84.0	84.3	81.0	75.1	67.6
July	2	68.7	68.9	69.1	70.3	73.2	72.9	68.2	80.3	99.2	80.8	77.1	73.7	72.9	68.4	76.9	75.5	80 1	79.3	76.5	72.6	68.4
	9	72.1	74.2	73.6	74.1	75.4	74.1	68 7	80.5	93.3	80.5	77.9	75.6	74.1	68.9	77.7	76.7	80.2	79.6	77.4	74.1	68.9
	16	74.1	77.0	73.6	76.5	78.5	76.5	70.0	90.6	111.1	83.9	84.6	78.9	76.6	70.1	87.1	83.8	87.6	86.0	81.8	76.5	70.1
	23	77.8	79.9	79.9	80.9	83.0	80.7	72.1	90.5	109.8	92.5	88.7	83.1	80.7	72.4	82.5	81.3	88.1	88.5	85.4	80.4	72.4
	30	73.7	76.9	76.2	77.2	79.7	79.0	73.2	86.5	103 6	89.1	85.2	80 2	79.0	73.4	79.7	79.8	85 2	85.8	82.8	78.8	73.3
Aug.	6	75.0	76.6	76.6	77.2	78 5	78.1	73.4	82.2	89.6	84.6	82.3	78.9	78.0	73 5	77.1	77.4	81.2	82.3	80.5	77.9	73.4
	13	69.3	71.7	72.9	74.2	77.1	77.0	73.1	81.0	98.2	85.3	81.7	77.2	76.9	73.2	77.5	76.6	82.3	83.1	80.1	76.7	73.1
	20	72.1	75 2	75.3	76.3	78.5	77.8	73.1	83.6	97.6	86 3	83.2	78.8	77.8	73.4	80.2	78.7	83.6	84.4	81.5	77.6	73.3
	27	69.1	71.0	73.4	75.1	78.5	78.2	73.5	78.9	97.2	85.2	82.1	78.3	78.1	73.7	73.4	74.4	81.9	83.3	81.0	77.7	73.6
Sept.	3	58.3	59.8	63.6	65.5	70.1	72.9	72.3	74.0	94.0	78 6	74.7	70.6	72.8	72.6	69.0	66.8	75.1	76.2	74.1	72.4	72.4
	10	62.7	68 1	67.2	68.9	73.0	73.2	70.9	78.6	104.6	83.8	79.6	73.5	73.3	71.3	73.1	71.1	80.0	81.1	77.1	73.3	71.2
	17	67.0	69.5	72.2	73.9	77.3	76.4	71.6	82.1	105.5	86.9	82.8	77.4	76.1	72.0	75.3	75.0	82.6	83.5	80.4	76.3	71.9
	24	60.5	60.8	65.8	67.6	71.1	73.6	71.7	71.3	90.5	77.1	74.2	71.6	73.4	71.9	65.6	64.8	73.9	75.1	74.1	73.0	71.8
Oct.	1	53.9	57.7	61.4	62.7	66.2	68.6	69.9	71.3	84.7	73.6	70.0	66.7	68.6	70.1	66.2	64 4	70.0	70.6	69.3	68.5	69.9
	8	53.5	52.0	59.7	62.0	65 9	69.7	69.0	74.0	97.0	76.5	72.5	68.0	69.6	69 3	65.6	62.7	72.5	73.4	71.1	69.2	69.2
	15	51.4	51.9	58.7	61.0	66.1	68.7	68.1	69.7	91.0	74 0	69.5	66.3	68.6	68.6	59.7	58.3	69.1	70.4	69.4	68.2	68.5
	22	52.1	52.5	57.3	58.4	61.9	65.1	66.9	63.2	73.0	65.5	63.4	62.0	65.0	67.0	58.6	56.6	62 8	63.6	63.7	64.7	66.9
	29	47.7	49.3	51.8	52.8	57.4	59.9	64.5	54.6	58.9	56 3	55.5	55.9	59.7	63.7	52.3	54.4	55.1	55.6	56.8	59.6	63.7
Nov.	5	40.3	40.8	46.2	47.6	51.6	55.8	61.2	54.4	64.0	54.0	52.2	51.3	55.6	61.2	48.8	45.2	51.7	52.6	53.3	55.7	61.1
	12	42.4	41.4	45.8	47.0	50.9	54.8	58.9	54.5	61.4	53.7	51.8	50.8	54.5	59.0	50.1	45.5	51.8	52.4	52.6	54.4	58.9
	19	41.0	38.9	43.6	44.6	48.2	52.3	57.1	53.9	62.0	52.0	49.7	48 3	52.3	56.4	48.6	44.7	49.4	49.8	50.0	52.0	57.0
	26	37.4	34.4	41.1	42.4	45.5	49.4	55.1	56.5	64.3	51.2	48.0	45.7	49.6	55.2	49.3	44.6	48.1	48.4	48.3	49.4	55.0

MEAN MONTHLY TEMPERATURE.

The mean temperature of so long a period as a month is relatively of little practical value considered alone in connection with our crops, but it makes certain points clearer to us than a more detailed statement, as for instance, the general rise and fall of the temperature of the soil. The accompanying diagram (Chart I) presents clearly the rise of



temperature to July, and then the more rapid cooling off of the air and surface than of the lower depths of the soil.

This diagram is interesting also in connection with the general discussion of the condition favoring the development of the cotton plant.

TEMPERATURE OF SOILS OF DIFFERENT CHARACTER OR TREATMENT.

The temperature of a soil does not depend alone upon the temperature of the air, rainfall and other meteorological conditions, or rather under equal conditions, the temperature of soils of different characters will vary greatly, depending, it would seem, largely upon these physical properties and conditions, especially as regards the water-holding capacity. This, we think, has an important bearing upon the growth and time of ripening of cotton.

The older experiments on the relation of the soil to heat were performed in the laboratory with dry soils, when it was found that under equal exposure to heat sand heated up more rapidly and to a higher temperature than clay. Practically in the field we find just the reverse is true, or that a clay soil attains a higher temperature than a sand. The reason for this is obvious, if the amount of moisture be determined in the two soils just after, and again some time after a heavy rain. It will be found that less water remains in the sand. More of the rainfall has undoubtedly descended through the sand by reason of the better drainage, but much more is evaporated at or near the surface of the sand, especially if the subsoil is of clay, as with us, which will materially lower its temperature. If we knew the amount of moisture evaporated from one soil over the other we could tell approximately how much the temperature would be lowered.

Our simple moisture determinations show very little here for the apparent loss by evaporation in sand over the loss

in clay, may be too high, because more water has drained down, or it may be too low, because more water has come up from below and been evaporated. It is probably too low, as Dr. Sturtevant has shown that contrary to the movement in the more moist climate of England, the movement of the soil moisture in New York State during the growing season is *up* rather than *down*. Some of our own observations seem to conform to this fact. There is relatively more evaporation from a sand or loam than from a clay than can be accounted for by the rainfall for the growing season. Obviously the character of the subsoil is an important factor. Table XI gives some comparative moisture determination in the loam and red clay soils for the first and second six inches in depth on certain dates as stated.

TABLE XI.

PER CENT. OF MOISTURE IN UNMANURED LOAM AND CLAY SOIL UNDER THE SAME EXPOSURE AND CULTIVATION IN COTTON.

Date.		Loam.			Clay.		
		Sample.	0-6 in.	6-12 in.	Sample.	0-6 in.	6-12 in.
May	5	XXXVIII	7.71	11.18	XXXIX.*	9.86	20.21
	5	-------	------	-------	XL.	17.67	24.40
	13	XLI.	11.98	12.02	XLII.	15.03	15.85
June	4	XLV.	14.42	14.69	XLVI.	19.78	22.31
July	30	LVI.	15.11	13.80	LVII.	22.90	23.08

*This sample inclines more to loam in the top six inches than the others under "clay."

TEMPERATURE OF A STIFF RED CLAY SOIL.

The effect of the character of a soil upon the time of ripening of a cotton plant may be stated in general terms as about two or three weeks earlier on a sandy than on a loam, and one or two weeks later on a clay than on a loam soil. On continuously unmanured and unimproved soil like ours, the

effect is much greater. The general opinion is, that the sandy soil is warmer and thus more heat (as temperature) is available to hasten the maturity of the cotton (a semi-tropical plant), but we have seen elsewhere that under normal conditions, just the reverse of this is true, within certain limits, of course.

After the growth of the plant (or "weed") in July, the most favorable conditions for the production of fruit and the maturity of the plant are for the temperature and moisture to rapidly diminish. These conditions we find in a sandy soil. We have shown indirectly* that the temperature of a sandy soil 3 inches deep at 1 P. M. of a warm, dry day, may be at least 10 degrees *colder* than the same depth in a red clay soil. There is much more moisture in the clay, and it seems probable, at least, that these conditions retard the ripening of the cotton and cause the plant to run to "weed" on clay and bottom lands.

The well known fact that cotton is more liable to "run to weed," or continued growth, on the rich, deep soils of bottom land and on clay soil, especially in wet seasons, and with deep cultivation in July and August, may be thus explained.

The special census report for cotton in Alabama states that in that State cotton is inclined to "run to weed" by deep cultivation, especially in August, but this is prevented in great part, by fertilizers and shallow cultivation. More inclined to run to weed on clay land. In the low lands the cotton is so late as to be generally caught by frost. "Ammoniated manures" is recommended as causing the plant to mature early and escape danger from frost.

We have before remarked on the shallow root system of cotton†—very different from corn or tobacco. The majority

*See comparative readings of thermometers in sandy tobacco soil of Granville county, and in our loam, report 1886, page 93, and in the loam and clay in this report.

†Report for 1886, and Bulletins.

of the roots probably do not go deeper in our soil than six inches, but spread out to a length of nine or ten feet or over close to the surface of the ground. Our moisture table shows that if by deep cultivation after the plants get well developed, the roots are cut off and induced to go lower, they will find two or perhaps three times more water in the second six inches of soil than in the first during the dry seasons when the plants are maturing. By deep, late cultivation the surface soil itself will contain much more moisture.

It is interesting in this connection to note a reason for the clean cultivation of cotton in its easily stages of growth. Crab and Bermuda grasses, the terror of the cotton planter, are desperately fought until the plant practically completes its growth in July or August, after which he cares little for them. Grass and weeds transpire a great deal of water, and act as pumps to artificially remove the water of the soil at that period of the life of the plant when the farmer is doing his best to retain the moisture in the soil by judicious stirring of the surface after each rain to retard evaporation. As an instance, on a piece of land, divided off into twentieth acre plots, separated by a road twelve feet wide, cotton was planted in the course of our experiment this year, and crab grass allowed to grow at will in the road (which was simply used to separate the plots), in no case approaching nearer than eighteen inches to the outside row of cotton in the plot. On July 16 we found only 4.91 per cent. of moisture in the soil six inches deep, where the crab grass was growing, and 10 55 per cent. among the adjacent cotton at the same depth. A small area of the loam was prepared and planted with the rest in cotton, with no after cultivation, and the land allowed to grow up in "poverty weeds." On this date (July 16) 6.70 per cent. of moisture was found in the first six inches, and 8.74 per cent. in the second six inches.

In the light of what has been said, we should expect this to mature the plant before the "weed" was well developed, and hasten the ripening of the crop. As a matter of fact,

the cotton in the outside rows of all the plots was hardly half as large as the rows next inside and was much earlier. Of course, if the grass was allowed to grow after the growth of the plant is practically completed, it might easily be a positive advantage. The writer has wondered whether sunflowers, planted late in among the cotton, say in July, about ten, twenty or more feet apart, in a rich, deep bottom land, would not hasten the ripening of the crop by artificially drying the soil and prevent the great loss a wet season or an early frost always occasions on such land.

Rye and barley are often seeded in the cotton field for pasturage at the last working of the crop, with good results, and it is possible that a more rapid grower, and a plant which transpires more moisture, might materially hasten the maturity of the surrounding plants.

The following table gives a summary of the mean weekly difference in temperature between a loam and clay soil in the same cotton field. The two sets of thermometers were about seventy-five feet apart with nearly the same exposure.

TABLE XII.

SUMMARY—MEAN WEEKLY DIFFERENCE IN TEMPERATURE BETWEEN CLAY AND LOAM SOIL, 1887. CLAY IS WARMER OR (—) COLDER THAN THE LOAM — DEGREES FAHRENHEIT.

WEEK ENDING.	7 A. M.				1 P. M.				7 P. M.				RAIN.
	Sur.	3 in.	6 in.	12 in.	Sur.	3 in.	6 in.	12 in.	Sur.	3 in.	6 in.	12 in.	Inches.
August 6	0.6	—0.1	0.1	0.5	1.3	—0.4	—0.5	—0.2	—0.5	0.3	0 8	—0.8	3.40
13	1.7	—0.6	0.7	0.5	1.6	1 7	—0.4	0.0	—0.8	0.7	0.3	—1.3	0.24
20	—0.5	—0.3	0.1	0.4	0.6	1.4	—0.5	—0.2	0.1	0.3	0.0	—1 4	2.22
27	0.9	—1.0	—0.2	0.2	—1.2	1.4	—0.7	—0.1	0.3	—0.6	—0.4	—1.4	4.34
Septemb'r 3	2.5	—1.7	—0.4	1.1	0.5	2.3	—0.8	0.3	0.4	—0.4	—0.4	—1.1	0.79
10	—1.7	—0.9	0.3	0.7	—4.0	3.6	—0.4	—0.1	0.3	0.1	—0.1	—1.4	0.00
17	1.9	—0.7	0.5	0.6	0.1	3.0	0.5	0.0	—0.1	0.0	0.2	—1.0	0.40
24	3.7	—1.4	0.0	1.1	—0.8	2.6	0.0	0.6	—0.4	—1.0	—0.5	—0.5	0.39
October 1	1.2	—0.9	0.2	1.2	0.1	1.6	0.2	0.7	0.0	—0.5	0.0	—0.3	1.23
8	5.8	—1.9	0.3	2.7	—3.7	4.9	0.5	0.1	—0.5	—0.8	0.2	—0.8	0.00
15	1.3	—1.9	0.3	1.6	—4.6	4.3	0.9	0.8	—3.2	—1.7	—0.2	—0.6	0.10
22	—0.7	—1 7	—0 1	1.2	—2.1	1.8	—0.4	0.7	—0.7	—0.5	—0.4	—0.1	2.63
29	—2.3	—1.9	—0.6	0.0	0.8	0.2	—0.2	1.2	—2.3	—1.3	—0.2	0.7	3.23
Novemb'r 5	—2.7	—3.8	—1.3	0.9	—3.8	0.8	—0.7	0.8	—0.1	—0.7	0.5	0.3	4.59
12	—2.0	—2.3	—0.2	0.7	—1.3	1.2	—0.2	1.0	—0.5	—1.8	—0.3	0.1	0.48
19	—1.5	—1.9	0.3	1.6	—1.8	1.8	0.0	1.2	0.0	—1.4	—0.2	1.9	0.15
26	—0.6	—2.1	0.3	1.8	1.6	3.3	0.4	1.4	—2.3	—0.1	1.1	0.4	0.00
Mean ..	0.5	—1.5	0.0	1.0	—1.0	2.1	—0.1	0.5	—0.6	—0.6	0.0	—0.4	24.19

A table giving the readings in detail will be found at the end of this report.

The rainfall over the whole period of seventeen weeks was 23.84 inches, against 7.47 inches over the same period of last year, which makes it seem probable that the comparative results would have been much more striking last year than they are this.

TABLE XIII.—HOURLY READINGS SEPT. 10—IN A LOAM SOIL.

HOUR.	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	MEAN
Air.	61.9	63.2	68.0	72.8	76.0	78.4	81.1	83.9	85.2	85.1	85.7	85.2	83.7	78.8	76.0	74.6	77.5
Surface	61.1	67.2	76.0	86.6	97.0	106.2	112.0	113.6	111.5	105.3	99.7	87.2	81.0	76.4	73.8	72.4	89.2
3 inches	68.4	68.2	69.2	71.9	75.9	80.2	84.6	88.0	90.3	91.4	91.2	89.7	87.1	84.7	82.2	80.4	81.5
6 inches	70.7	70.0	70.1	71.2	73.4	76.3	79.4	82.6	85.0	86.7	87.7	87.7	86.8	85.0	83.3	82.0	79.9
12 inches	74.5	74.3	73.9	73.7	73.6	73.7	74.2	74.9	75.9	76.9	77.6	78.6	79.1	79.0	79.6	79.5	76.2
IN A STIFF RED CLAY SOIL.																	
Surface	59.7	69.0	76.2	84.4	96.4	101.1	104.2	110.2	109.0	108.2	102.1	93.2	83.1	77.5	74.4	73.2	88.6
3 inches	67.3	67.5	69.4	73.4	77.3	83.2	88.2	92.2	94.5	95.4	94.9	92.2	89.0	85.2	82.2	80.3	83.6
6 inches	70.8	70.6	70.6	71.8	73.9	76.4	79.5	82.4	85.0	87.0	88.0	88.0	87.0	85.2	83.6	82.3	80.2
12 inches	75.2	75.0	74.8	74.6	74.3	74.3	74.4	74.7	75.1	75.7	76.2	76.9	77.2	77.5	78.0	78.2	75.7
DIFFERENCE—THE CLAY SOIL IS WARMER OR COLDER (—) THAN THE LOAM.																	
Surface	—1.4	—1.8	0.2	—2.2	—1.2	—5.1	—8.8	—3.4	—2.5	2.9	2.4	6.0	2.1	1.1	0.6	0.8	—0.6
3 inches	—1.1	—0.7	0.2	1.5	1.4	3.0	3.6	4.0	4.2	4.0	3.7	2.5	1.9	1.5	0.0	—0.1	1.9
6 inches	0.2	0.6	0.5	0.6	0.5	0.1	0.1	—0.2	0.0	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3
12 inches	0.7	0.7	0.9	0.9	0.7	0.6	0.2	—0.2	—0.8	—1.2	—1.4	—1.7	—1.9	—1.5	—1.6	—1.3	—0.5

Table XIII gives hourly readings, with the difference in temperature, between these soils on September 10, and will prove of interest if carefully studied.

It seems strange at first sight that the *surface* of the sand is often or generally warmer than the clay, but this may be partly due to the greater amount of heat radiated from the surface of the sand. It is improbable that our thermometers give the true temperature of the exact surface of the ground.

INFLUENCE OF MOISTURE UPON THE TEMPERATURE OF THE SOIL.

It has been stated that the warmer clay soil contains more moisture than the sand or loam, and it has been shown that the relative temperature of the loam falls in proportion as the relative moisture content is less, but the contrary is the case where soil of the same character is compared. The more moisture the colder the soil, as is commonly believed.*

*See Table at back of this report; also compare temperature of meadow land, report 1886, page 111.

TABLE XIV.

DIFFERENCE IN TEMPERATURE BETWEEN A LOAM AND A SOIL INCLINING MORE TO RED CLAY, ABOUT 40 FEET DISTANT IN THE SAME COTTON FIELD. THE CLAY IS WARMER OR COLDER (—) THAN THE LOAM — DEGREES FAHRENHEIT.

DATE.	7 A. M.			1 P. M.			7 P. M.			Rel'ive Humidity	Rain, Inches	Sunshine. h. m.	Wind. Miles.	Condition of Loam Soil.
	3 in.	6 in.	12 in.	3 in.	6 in.	12 in.	3 in.	6 in.	12 in.					
April 19	—1.1	0.3	1.6	3.6	1.5	0.8	—0.7	1.7	1.5	67.7	.....	12.05	196	
20	—0.3	0.2	0.7	2.2	1.1	0.9	—0.9	1.0	1.0	74.7	trace.	3.05	108	
21	—0.8	0.1	.....	4.2	1.3	0.8	—0.1	1.7	1.4	64.0	trace.	11.00	91	
22	—0.2	0.6	1.0	1.7	0.9	1.0	0.1	1.2	1.2	66.0	trace.	2.10	266	
23	0.7	1.1	1.1	2.3	1.4	1.3	—0.4	1.6	1.6	66.0	.....	6.45	254	
24	—0.6	1.0	1.5	5.4	2.0	1.5	0.8	2.4	2.0	56.0	.....	9.30	166	Dry.
25	0.4	1.1	1.5	0.1	0.5	1.2	—0.8	0.3	1.0	88.7	1.05	0.00	241	
26	—0.6	—0.5	0.5	1.9	0.9	0.7	0.1	1.0	0.7	68.7	0.01	10.15	144	
27	0.0	0.0	0.6	0.3	0.3	0.6	—2.0	0.1	0.7	60.3	0.02	8.45	211	
28	—0.3	0.4	0.6	—1.0	0.4	0.7	—1.1	0.2	0 6	79.3	0.28	4.45	259	
29	—1.2	0.0	0.4	1.6	0.7	0.7	—1.0	—0.3	0.5	37.0	0.06	9.45	383	Wet.
30	—0.9	—0.6	0.0	0.6	—0.4	0.3	—2.1	0.1	0.5	35.3	.....	10.28	286	
May 1	—0.3	—0.2	0.2	2.7	0.4	0.4	—1.1	0.5	0.8	47.0	.....	11.45	105	
2	—0.5	0.2	0.7	1.8	0.8	0.6	0.9	0.0	1.1	57.3	.....	11.45	171	
3	—0.8	0.7	1.0	3.4	1.7	1.3	0.1	1.6	1.3	60.3	.....	11.40	139	
4	0.5	1.3	1.5	3.7	2.0	1.7	0.7	1.9	1.8	64.3	.....	11.40	122	
5	0.7	1.6	1.7	4.1	2.1	1.7	1.5	2.0	1.7	67.3	.....	10.30	176	Dry.
6	0.9	1.0	1.4	2.9	1.7	0.6	0.1	1.5	1.1	79.3	0.30	2.10	196	
7	0.4	0.9	0.8	1.1	1.3	1.0	.....	.....	.....	78.3	0.22	6.40	152	
Mean	—0.2	0.5	0.9	2.3	1.1	0.9	—0.3	1.0	1.1					

High winds.

TABLE XIV—(Concluded). HOURLY READINGS MAY 5, IN THE LOAM SOIL.

HOUR.	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	Mean.
Air.	62.0	63.4	68.6	70.8	72.6	75.0	79.0	81.3	82.2	83.0	81.9	79.9	78.8	76.0	73.1	71.4	79.6
Surface		64.4	72.3	77.5	81.9	88.2	102.7	106.6	107.1	101.9	95.1	85.3	80.7	74.3	70.9	68.9	85.2
3 inches	64.9	65.0	66.3	68.9	71.6	74.9	78.7	81.8	83.8	84.3	83.7	82.2	80.0	77.3	75.0	73.1	75.7
6 inches	66.7	66.1	66.0	66.5	67.7	68.8	70.7	72.9	74.9	76.3	76.9	77.2	76.8	76.0	74.9	73.7	72.0
12 inches	67.5	67.1	66.9	66.6	66.6	66.5	66.8	67.3	67.9	68.	69.3	70.0	70.4	70.7	70.8	70.7	68.4
IN THE CLAY SOIL.																	
Surface		65.2	76.4	82.2	85.4	90.5	106.0	100.5	107.0	98.2	93.4	83.9	79.6	73.7	70.9	69.4	84.8
3 inches	63.8	65.7	65.7	70.3	73.2	77.7	82.6	85.9	87.9	87.2	86.2	83.7	81.0	77.8	75.1	73.2	77.3
6 inches	68.2	67.7	67.7	68.2	69.3	70.6	72.6	75.0	77.1	78.6	79.2	79.4	79.0	78.0	76.8	75.5	73.9
12 inches	69.1	68.8	68.5	68.2	68.1	68.1	68.4	69.0	69.6	70.2	71.0	71.8	72.2	72.4	72.5	72.3	70.0
DIFFERENCE — WARMER OR COLDER (—) IN THE CLAY.																	
Surface		0.8	4.1	4.7	3.5	2.3	—6.7	—6.1	—0.1	—2.7	—1.7	—1.4	—1.1	—0.6	0.0	0.5	—0.4
3 inches	—1.1	0.7	—0.6	1.4	1.6	2.8	3.9	4.1	4.1	2.9	2.5	1.5	1.0	0.5	0.1	0.1	1.6
6 inches	1.5	1.7	1.7	1.7	1.6	1.8	2.9	2.1	2.2	2.3	2.3	2.2	2.2	2.0	1.9	1.8	2.0
12 inches	1.6	1.7	1.6	1.6	1.5	1.6	1.6	1.7	1.7	1.6	1.7	1.8	1.8	1.7	1.7	1.6	1.7

MOISTURE FOUND IN THE SOIL. PER CENT.

DATE.	Sample.	Soil.	0–6 ins.	6–12 ins.	12-18 ins.	18-24 ins.
April 22	XXXVI.	Loam.	8.38	11.69	13.69	16.12
29	XXXVII.	Loam.	18.43	14.74	17.67	19.64
May 5	XXXVIII	Loam.	7.71	11.88	17.05	19.68
5	XXXIX.	*Clay.	9.86	20.21	22.90	22.36
5	XL.	†Red"	17.67	24.60	24.79	23.26

*Where the above temperatures were taken. About 40 feet from the loam. †Red clay about 70 feet from the loam.

This effect of soil moisture upon the temperature is well illustrated in Table XIV, giving the difference in temperature between the loam and red clay soil. The duplicate set of thermometers was about 40 feet from the loam where the soil is not such a pure clay as in the experiment just recorded. It will be seen that as the soils dry the difference in temperature increases, and is greatest when the loam contains the least moisture. Hourly readings of the thermometers are given for May 5, and the moisture contents of the loam for three dates, while on May 5 the moisture content of the clay near the thermometers and of the full red clay soil where the results of Table XII were obtained. An interesting feature of this table is the period of high winds during the wet spell in April (when the soil became quite saturated), which so quickly dried out the soil that on May 5 vegetation was suffering for rain.

Another table, which it is hardly necessary to give, shows the mean temperature at 1 P. M. of a heavy loam, inclining to red clay, at a depth of 3 inches, for a period of 17 days (May 8—24 inclusive), to be 3.4 degrees higher than at the corresponding depth in the loam soil at the regular set of instruments.

TEMPERATURE OF "NEW LAND."

In the spring of 1886, a tract of about one and a half acres of land, facing the Hillsboro road, was cleared of a thick growth of black-jack and scrub oaks, and without any application of manure or fertilizer, was planted in tobacco. The crop, as such, was a failure, the plants maturing and producing seed late but without attaining a normal size. The soil, unlike any other on the Farm, is a fine grey sandy loam, well suited for tobacco and for early market truck. It was level with good exposure, and was very desirable but very poor. We had determined last year, by pot experiments with cotton, that the soil responded readily to nitro-

genous fertilizers, and but little to either potash or phosphoric acid, so in the spring plots were laid off on this land and fertilizers applied in different mixtures to study the same question practically in the field. No organic nitrogen was used except on six of the plots at one end pounded cotton seed was added from small undecomposed composts. The crop started off badly; there was a very poor stand after one replanting (almost amounting to a reseeding), and what was up had not started to grow by June 26, when the duplicate set of soil thermometers was placed in position in the middle of a five foot path separating two of the plots. The plants had hardly attained any size by the middle of July, when the experiments, by an unforeseen incident, had to be discontinued. The thermometer readings, as appear in Table XV, were giving very unforeseen and interesting data, and we were preparing to investigate the matter further, and were sorry to give the work up. The results are interesting as indicating a decided similarity between the physical properties of this and the red clay soils to a marked degree. As a mean for the twenty-four days the temperature of the sandy soil is 1.3 degrees colder 3 inches deep, than the loam at 7 A. M., but 3.5 degrees hotter at 1 P. M. A result at variance with the record of these same thermometers in the sandy tobacco soils of Granville county last year. Nearly all the other readings show the sandy loam to be notably colder than the loam soil. The soil had no "heart." It did not respond to the large dressings of various mixtures of chemicals applied. The crop on the manured was no better than on the unmanured plots.

To bring such land up it would be considered necessary to improve its physical condition by thorough and deep plowing, followed by a well manured crop like potatoes, or a deep rooted crop like corn, or by peas to be turned under.

Do these thermometer readings suggest that the physical condition of this fine compact sand was akin to our red clay soil as a reason for the failure of the tobacco and cotton

TABLE XV.—DIFFERENCE IN TEMPERATURE BETWEEN A LOAM AND A SANDY LOAM NEAR PLOT 94. THE SAND IS WARMER OR COLDER (—) THAN THE LOAM SOIL — DEGREES F.

DATE.	7 A. M.				1 P. M.				7 P. M.				Relative Humid'y	Rain. Inches.	Sunsh'ne H. & M.	Wind. Miles.
	Sur.	3 in.	6 in.	12 in.	Sur.	3 in.	6 in.	12 in.	Sur.	3 in.	6 in.	12 in.				
June 26	—0.1	—1.2	0.7	—1.0	3.1	4.9	—1.0	—1.0	0.2	0.8	1.2	—0.7	66.3	.....	13.00	141
27	—1.3	—1.6	1.3	—0.6	1.4	3.2	0.2	—0.7	0.4	0.2	0.9	—0.5	69.3	.....	5.10	161
28	2.2	—1.8	0.2	—0.6	—4.6	—1.0	4.7	—0.2	—2.6	—0.3	—0.2	—1.1	63.7	trace.	12.15	118
29	2.9	—2.6	—0.8	—1.5	—2.3	5.0	—1.3	—1.0	—2.5	—2.3	—0.9	—0.5	61.3	.....	13.15	91
30	0.9	—2.1	—0.9	—1.8	1.1	5.4	—1.5	—1.0	—2.9	—1.8	—0.7	—0.5	71.0	.....	13.10	85
July 1	3.3	—1.8	—1.1	—1.6	—3.4	4.6	—1.1	—1.3	—2.1	—2.6	—0.9	—1.7	74.0	.....	9.50	89
2	0.7	—2.6	—0.9	—1.7	7.3	6.0	—0.9	—0.8	—0.5	—1.1	—0.5	—0.2	74.7	.....	9.35	115
3	—1.1	—2.8	—0.7	—1.5	—4.4	5.3	—0.3	—0.8	—0.7	—0.7	—0.2	—0.4	84.7	trace.	6.25	121
4	—0.2	—1.4	—0.2	—1.1	1.1	0.5	0.2	—0.9	—0.1	—0.7	—0.1	—0.6	95.0	0.90	0.00	194
5	—0.4	—0.9	0.0	—1.1	—7.4	4.0	—0.2	1.7	0.9	—0.3	—0.4	0.0	91.0	trace.	*	147
6	—0.4	—0.1	0.5	—0.3	1.9	3.1	—0.2	0.4	—4.3	—1.1	1.2	0.8	87.7	.....	7.10	145
7	0.1	0.5	0.3	0.3	0.6	1.6	—0.1	0.1	0.3	—0.9	0.5	0.6	91.0	0.25	0.00	109
8	—0.2	—0.3	0.2	—0.2	—5.9	2.1	—0.7	0.0	—0.6	—0.5	0.5	0.4	87.7	1.88	6.45	97
9	—1.4	—0.8	0.3	—0.2	0.4	2.2	—0.7	1.7	0.7	—0.9	0.4	0.0	80.0	.....	10.30	148
10	0.3	—0.7	0.0	—0.4	—0.6	1.5	—1.2	—0.4	—0.5	—2.2	—0.6	—0.4	67.7	.....	10.05	159
11	—0.2	—1.6	—0.1	—0.8	—2.1	1.7	—1.4	—0.7	—2.1	—0.5	—0.7	—0.5	67.0	.....	10.45	84
12	—0.3	—0.8	—0.2	—0.7	—7.1	0.4	—0.6	—0.7	—0.9	0.2	0.1	0.0	77.3	.....	12.05	36
13	4.7	—1.9	—1.3	—1.1	—8.1	4.0	—1.4	—0.1	—1.6	—1.2	—0.1	0.3	69.7	.....	11.25	39
14	0.5	3.1	—1.4	—1.5	—3.9	4.7	—2.2	—0.8	—0.6	0.4	—0.3	0.3	70.0	.....	12.10	56
15	0.1	—1.4	—1.4	—1.7	—4.9	5.1	—1.8	—0.7	—0.3	1.2	0.0	0.5	73.0	.....	11.10	63
16	0.6	—1.8	—1.3	—1.7	—2.4	5.7	—1.9	—0.6	0.1	1.9	0.5	0.8	71.3	.....	12.00	60
17	—0.7	—2.3	—1.2	—1.3	—3.9	4.5	—1.8	—0.4	0.1	0.3	0.2	0.7	60.0	.....	13.05	109
18	—3.4	—2.2	—1.9	—1.2	—1.9	4.5	—2.1	—0.4	0.3	—0.2	—1.2	0.8	61.7	.....	12.10	82
19	0.9	—2.2	—1.6	—1.5	—4.3	4.9	—1.1	—0.3	—0.1	—3.4	—0.7	0.8	72.3	0.35	9.50	154
Mean ..	0.3	—1.3	—0.5	—1.2	—2.1	3.5	—0.8	—0.4	—0.8	—0.6	—0.1	0.0				

*Record lost. Cloudy nearly all day.

crops? Unfortunately no moisture determination was made in this soil this year, and no other physical examination could be made.

Sunshine Record.

A continuous photograph record has been kept of the sunshine during the growing season with the home-made apparatus described last year. It is interesting to compare the record of this year with last, and with the records at Geneva, New York, the only other records of a like character we have. The instrument fails to record from 8 to 20 per cent. of the actual sunshine, depending upon the moisture, haze or smoke in the atmosphere in the early morning and late in the afternoon.

Owing to our more southern latitude, we have 59 hours 45 minutes less of possible sunshine during the six months of actual growing season than at Geneva, as appears in the subjoined table. This is equal to $4\frac{1}{2}$ days of our average length at this time.

HOURS AND MINUTES OF POSSIBLE SUNSHINE.

	N. C. Exp't Farm.	N. Y. Exp't Station.
May	436-02	453-29
June	436-56	457-03
July	443-48	462-11
August	418-26	428-47
September	372-27	373-38
October	349-33	341-49
Total	2,457-12	2,516-57

It is interesting to note in the next place the actual amount of sunshine recorded in the two years here and in Geneva. The large excess this year over last will be noted. The important bearing of this during the month of June

has already been noticed. During the season from June 1 to September 30, there were 188½ hours more sunshine recorded in 1887 than in 1886, or nearly fourteen days more of actual sunshine. This must have had an important influence upon crop products, considering the excessive rainfall in 1887.

HOURS AND MINUTES OF SUNSHINE RECORDED.

	N. C. Exp't Farm.		N. Y. Exp't Station.	
	1886.	1887.	1885.	1886.
May	....	264-25	214-30	235-45
June	171-55	285-50	281-00	252-15
July	221-15	248-40	289-30	243-15
August	196-10	213-35	207-00	240-15
September	187-00	217-50	231.30	200-30
October	213-50	163-00	136-30	142-45
Total		1,393-20	1,359-00	1,314-45

PER CENT. OF POSSIBLE SUNSHINE.

	N. C. Exp't Farm.		N. Y. Exp't Station.	
	1886.	1887.	1885.	1886.
May	....	60.7	47.3	51.9
June	47.9	70.0	61.5	54.2
July	50.3	59.9	62.6	52.6
August	47.6	51.2	48.3	56.0
September	51.1	58.1	62.0	53.7
October	61.0	46.2	39.9	41.8
Mean	51.6	57.7	53.7	51,7

Date.	MAY			JUNE.			JULY.			AUGUST.			SEPTEMBER.			OCTOBER.			NOVEMBER.		
	No. of hours		Per Ct	No. of hours		Per Ct	No. of hours		Per Ct	No. of hours		Per Ct	No. of hours		Per Ct	No. of hours		Per Ct	No. of hours		Per Ct
	Pos-sible.	Recor ded.	Of pos sible.	Pos-sible.	Recor ded.	Of pos sible.	Pos-sible.	Recor ded.	Of pos sible.	Pos-sible.	Recor ded.	Of pos sible.	Pos-sible.	Recor ded.	Of pos sible.	Pos-sible.	Recor ded.	Of pos sible.	Pos-sible.	Recor d d.	Of pos sible.
1	13.39	12.05	88.5	14.27	6.50	47 3	14.33	9.50	67.6	13.58	6.45	48 3	12.57	11.05	85.6	11.50	7.50	66.2	10.42	5.30	51.4
2	13.41	11.30	84.0	14.27	*.....	.....	14.32	9.35	65.9	13.56	3.10	22.7	12.53	11.10	89.4	11.48	9.50	83.3	10 41	7.40	71.8
3	13.43	11.45	85.7	14.28	12.30	86.4	14.32	6.25	44.2	13.55	2.40	19.2	12.52	9 15	71.9	11.45	8.30	72.3	10.39	7.55	74.3
4	13.45	11.45	85.5	14.29	11.20	78.2	14.31	0.00	0.0	13.53	4.10	30.0	12.50	10.10	79.5	11.43	9.35	81.8	10.37	7.45	73.0
5	13.46	10.40	77.5	14.31	10.20	71.2	14.30	**.....	.....	13.51	9.15	66.8	12.47	7.10	56.1	11 41	7.25	63.5	10.35	7.35	71.7
6	13.48	1.40	12.1	14.32	6.45	46 4	14.30	7.10	49.4	13.50	9.10	66.3	12.46	10.30	82.2	11.39	9.15	79.4	10.33	6.30	61.6
7	13.49	6.40	48.3	14.33	10.15	70.4	14.29	0.00	0.0	13.49	5.40	41.0	12.43	8.30	66.8	11.36	9.15	79.7	10.31	1.20	12.7
8	13.51	9.10	66.2	14.33	10.40	73.3	14.28	6.45	46.7	13.46	1.20	9.7	12.42	9.25	74.1	11.35	9.10	79.1	10.30	1.55	18.3
9	13.53	4.05	29.1	14.34	9.40	66.4	14.28	10.30	72.6	13.43	11.15	82.0	12.39	9.10	76.1	11.33	9.00	77.9	10.28	0.00	0.0
10	13.55	1.40	12.0	14 34	6.30	44.6	14.26	10.05	69.9	13.42	12.00	87.6	12.37	10.45	85.2	11.30	9.15	80.4	10.26	0.00	0.0
11	13.56	8.55	64.0	14.35	*.....	.....	14.25	10.45	74.3	13.40	10.50	79.3	12.35	8.10	64.9	11.27	3.50	33.5	10.23	6.15	60 2
12	13.58	9.00	64.4	14.35	13.10	90.3	14.25	12.05	83.8	13.38	10.45	79.8	12.33	9.10	73.0	11.25	8.35	75.2	10.22	7.15	69.9
13	14.00	7.50	56.0	14.35	13.00	89.1	14.24	11.25	79.3	13 36	4.15	31.2	12.31	10.30	83.9	11.23	9.00	79.1	10.20	6.00	58.1
14	14.02	11.10	79.6	14 35	13 10	90.3	14 23	12.10	84.6	13.34	4.05	30 1	12.29	7.00	56.1	11.21	9.00	79.3	10.18	0.20	3.2
15	14.04	12 30	88.7	14 36	11.30	78.8	14.21	11.10	77.8	13.32	5.30	40.6	12.26	5.20	42.8	11.18	8.30	75.2	10.17	4.40	45.4
16	14.06	12.00	85.1	14 37	13.00	88.9	14.20	12.00	83.7	13.30	11.00	81 5	12.23	8.30	65.9	11.16	5.50	51.8	10.15	7.05	69.1
17	14.07	11.25	80.9	14.37	12.35	86.1	14.19	13.05	91.4	13.29	3.35	26.8	12.21	7.25	60.1	11.14	4.20	38.6	10.13	3.30	63.6
18	14.09	11.30	81.8	14.38	12.45	87.1	14.18	12.10	85.1	13.26	5.45	42.8	12.20	0.40	5.0	11.12	0.00	0.0	10 12	0.00	0.0
19	14.09	7.30	54.0	14.37	13.10	90 1	14.16	9.50	68.9	13.24	2.00	14.9	12.17	5.20	45.4	11.09	0.00	0.0	10.10	0.00	0.0
20	14.11	10.20	72.9	14.36	12.40	86.8	14 15	9.40	67.8	13 23	9.45	72.9	12.16	10.15	83.6	11.07	0.00	0.0	10.09	5.45	56.6
21	14.13	8.00	56.3	14 36	10.15	70.2	14.14	6.15	43.9	13.21	9.50	73.7	12.14	9.45	79.7	11.05	8.00	72.2	10.07	6.00	59.3
22	14.14	1.20	9.4	14.36	0.00	0.0	14.13	7.25	52.2	13 19	5.55	44 4	12.11	6.10	50.6	11.03	8.30	76.9	10 06	6.30	64.3
23	14.16	2.00	14.0	14.36	6.35	45.1	14.12	3.15	22.9	13.16	6.10	46.5	12.08	0.00	0.0	11.01	7.05	64.3	10.05	6.00	59 4
24	14.17	6.15	43.8	14 36	5 30	37.7	14.11	7 30	52 9	13.14	8.10	61.7	12.05	9.20	77.2	10.59	1.15	11.4	10.03	6.45	67.1
25	14.17	11.30	80.5	14.36	6.30	44.5	14.10	12.30	88.6	13.12	10.45	81.4	12.03	6.10	51 2	10.56	0.00	0.0	10.01	6.20	63.2
26	14.19	11.20	79.2	14.35	13.00	89 1	14.08	11.35	81.9	13.10	4.35	36.1	12.02	9.00	74.8	10.55	0.00	0.0	10.00	2.35	26.0
27	14.20	11.30	80.2	14 34	5.10	35.5	14.06	8.45	62.1	13.08	0.00	0.0	11.59	1.50	15.3	10.53	0.00	0.0	9.58	5.25	54.4
28	14.22	11.30	80.0	14.34	12.15	84.1	14.05	6.25	45.6	13.05	4.20	33.1	11.58	0.15	2.1	10.51	0 00	0.0	9.55	0.00	0.0
29	14.23	12.40	88.1	14.33	13.15	91.1	14.03	6.20	45.1	13.04	8.40	66.3	11.55	3.20	28 0	10.49	0.00	0.0	9.54	7.00	70.8
30	14 25	5.10	35.8	14.33	13.10	90.5	14.01	4.00	28.5	13.02	11.25	87.6	11 53	2.00	16.8	10 45	0.00	0.0	9.53	6.45	68.5
31	14.26	0.00	0.0	.....	.....	.....	14.00	**.....	.....	13.00	10.40	82-1	.....	.....	.....	10.43	0.00	0,0	.....	.....	.....
	436.02	264.25	60.7	‡436.58	285.50	70 0	‡443 48	218.40	59.9	418.26	213.35	51.2	372.27	217.50	58.1	349.33	163.00	46.2	308.28	140.20	45.5

*Records lost. Partly cloudy. **Records lost. †In comparing the total sunshine possible with that recorded,29 hours, 2 minutes, and 28 hours, 30 minutes, should be taken from total possible in June and July respectively as two days, records were lost in each month.

Some Observations upon the Cooling of the Soil due to Radiation and Evaporation of Soil Moisture.

We have observed such notable differences in temperature in adjacent soils of different composition, under practically the same meteorological conditions and cultivation, that we have been led to continue and enlarge the scope of our work with the view of studying particularly the occurrence of late and early frosts. We have shown that a clay soil is warmer than a sand, and indirectly that this difference may amount to at least 10° at a depth of 3 inches below the surface during the growing season. This loss of heat, as temperature, may have an important bearing upon the adaptability of crops to soils, besides indicating directly or indirectly causes which may control the production in quantity or quality and the time of maturity. The subject is so complex that our observations should be accepted largely as data in lieu of a further and more comprehensive study.

We will call attention here to some data collected upon the specific heat of soils, the evaporation of moisture, and the direct loss of heat from the surface of the earth by radiation and reflection.

In the determination of the specific heat, 200 or 300 grams of *air-dry* soil were sealed up in a thin glass flask and submerged in boiling water for 15 or 20 minutes; the surface of the flask then quickly wiped dry and submerged in 500 or 600 c.c. of distilled water at the temperature of the air. The flask was slowly agitated, and a thermometer suspended in the water indicated the highest temperature of the mixture. The following data will serve as examples, the flask weighing, with the cork, 30 grains, and the distilled water for the mixture being contained in the same vessel each time:

	Loam. 1st 6 inches of Sample XIV.	Red Clay. 1st 6 inches of Sample XL.
Weight of soil	300 grams.	200 grams.
Temperature of soil	212 degrees (nearly)	212 deg. (nearly).
Weight of water	600 grams.	500 grams.
Temperature of water	82.5 degrees.	75.5 degrees.
Temperature of mixture	90.0 "	81.8 "
Specific heat	0.1227	0.1286

The formula, $c = \frac{m(x-t)}{M(T-X)}$ was used, where c. is the specific heat of the body, M its weight, and T its temperature, and m the weight of the cold water t its temperature, and x the temperature of the mixture.

It will be observed that the specific heat of the red clay is slightly higher than the loam, indicating, as was to be expected, that the loam has the greater capacity for heat, and as the absorbing and radiating powers are identical, will lose heat more rapidly by radiation than the clay.

Practically, however, we find the loam soil notably colder than the clay. We were, therefore, next led to consider the effect upon the temperature of the soil of the greater evaporation of water from the loam than from the clay. Assume the air-dry weight of both soils under cultivation to be 1,800,000 pounds per acre to a depth of 6 inches. On April 29, both were about saturated from continued rains, as 18.43 per cent. of moisture was found in the first six inches of the loam.* One week later (May 5) the loam soil contained 7.71 per cent. of moisture and was rather dry, while the clay contained 17.67 per cent. of moisture. At this time there was 236,000 pounds more moisture in the first 6 inches of the acre of clay than in the loam, from the excess of evaporation or drainage from the loam over the clay.

The table further shows this difference in the moisture

*See Table XIV, p, 189.

content of the soils to decrease in proportion to the depth, and is practically nothing at a depth of over 24 inches. The same subsoil extends under both soils, consisting of ten or twelve feet of red clay, the only difference seeming to be in the character and depth of the superimposed soil.

As before observed, the difference in temperature between two adjacent soils seems to be relatively proportionate to the relative moisture content, and as a consequence, the temperature of these soils is practically the same 24 inches deep. Evaporation being a surface phenomena, other things being equal, the total amount of evaporation will depend upon the relative ease with which water can be supplied to the surface by capillary action from below. But it may be urged that the rule works both ways, and that much of the excess of water lost by the loam soil over the clay, may have been carried down by gravity and capillary action and lost in the lower depths of the earth rather than by direct evaporation. In other words, while there would probably be more evaporation, there would likewise be more transpiration of water from the loam soil. The former would have a tendency to cool the soil, the latter to warm it. In the case of these soils this transpiration or under drainage could hardly have a notable relative value, as the ten or twelve feet of compact red clay underlying each soil will practically control the movement of moisture to or from any great depth, and it would seem probable that the excessive loss of moisture from the loam above referred to took place by direct evaporation, and was confined to a depth not greatly exceeding 24 inches.

It seems probable also, as pointed out by Dr. Sturtevant, that the movement of soil moisture is up rather than down during our growing season—the reverse of what is believed to occur in the more moist climate of England. It must be remembered also, that the movement of soil moisture below superficial depths is probably very slow. My attention was forcibly called to this by a well-digger of considerable expe-

rience, who has dug and had charge of most of the wells on the Agricultural Society grounds for many years. He stated that the level of the water in an average well was lowest during the winter months, and gradually rose (notwithstanding spring and summer droughts) and reached its maximum about August. He explained this by stating that it takes six months for the winter rains to descend through the thirty or forty feet and raise the water level. We commenced a series of measurements bearing on this point, but they were given up through pressure of other work. It is interesting to observe, however, that measurements made by Mr. Goff, of the New York Experiment Station in 1887,* which have just come to hand, seem to confirm the statement of the well-digger and point to the extremely slow movement of soil moisture, at least at considerable depths.

Assuming most of this excessive loss of water from the loam soil to be due to evaporation, and that this evaporation takes place all at one time.

Now any weight of water, by its own evaporation, will lower its own weight of water 965°F., or ten times its own weight 96°, or on the supposition that the specific heat of soil is the same as that of water, it will lower the temperature of ten times it own weight of soil 96°. But the specific heat of the soil being one-eighth that of water, it will lower the temperature of ten times its weight of soil 96 x 8=768°. In reality, this evaporation takes place comparatively slowly, so the effect upon the temperature of the soil at any moment of time is small. While we cannot apply this practically to our work, still as an illustration it presents the matter clearly to the mind. Storer says:† "At Munich Peltenkofer reckons the rate of the lateral flow of the ground water at fifteen feet daily, while in the rather dense chalks of Eng-

*Annual Report N. Y. Experiment Station 1887, p. 115.

†"Agriculture," Vol. I, p. 69.

land, engineers have supposed that the water moves three feet downward in the course of a year.

"It is plain on the face of the matter, that in general, deep-lying ground water can have comparatively little movement."

LOSS OF HEAT BY RADIATION AND REFLECTION.

The following table gives the results of some observations on the direct loss of heat by radiation and reflection, with such other data in our possession as seems to bear upon the subject. The figures in columns 1, 8, 11, 12 are from instruments exposed in a well ventilated instrument shelter; 5, 6, 9, 10 are the readings from colorless alcohol thermometers (terrestrial radiation thermometers) exposed in a nearly horizontal position over the loam and clay soils, the bulb being six inches above the surface and exposed to direct sunlight; 13, 14 are the lowest or minimum readings recorded by these same instruments during the previous night. The pounds of moisture per acre given in the last column refers tothat found in the first and second six inches of the loam soil. The terrestrial radiation thermometer over the loam was loaned by the U. S. Signal Service. All the instruments were carefully compared by a long and satisfactory series of comparative readings, and corrections applied when necessary to make them agree with our standard thermometer.

It will be observed that the temperature of the red clay soil was notably higher at 1 P. M. than the loam, while the temperature six inches above the surface of the ground, as indicated by the thermometers, was notably colder over the red clay than over the loam. In the main, the differences in soil temperature are much the greater, probably showing the effect of the greater evaporation of water from the loam. It must be borne in mind that the radiation thermometers were only about 70 feet distant, and the circulation of air may have modified the readings.

It would seem that these differences must have a most direct and important bearing upon our practical agriculture. From my own observation, I have no doubt that comparing sand (like the Granville county tobacco soil), and a stiff loam or clay, that it might be found that the roots of a shallow rooted plant like cotton may be exposed during the best growing season to a temperature 10° lower, and the body of the same plant to a temperature 10° higher, if growing in a sand than in a clay soil in adjacent fields. Considering the difference in moisture content, this would have a most important influence on the development, time of maturity and production of a plant in a green-house, and why not in the field?

It seems to the writer that this subject, if followed out in its relation to agricultural practice, would yield results of the utmost interest and value to our farmers, particularly in the production of cotton, the different grades of tobacco and other important crops of this State. And there is no place the writer has visited where the natural advantages and facility for the investigation are so great and where the knowledge so gained will be of such general value to the farmers as in North Carolina, with her comparatively large extents of typical, well defined soils of markedly different character, providing with an equitable climate conditions for the successful growth of a great variety of crops. The

COMPARATIVE READINGS OF RADIATION THERMOMETERS SIX INCHES ABOVE UNMANURED LOAM AND STIFF RED CLAY SOILS IN A COTTON FIELD ON THE N. C. EXPERIMENT FARM, 1887.

DATE. 1 P. M. and 7 P.M, refer to the first date given.	1 P. M.							7 P. M.			7 A. M.					Relative Humidity. Per cent.			Wind 10 P. M. to 7 A. M.	Sunshine		REMARKS. Note - Figures refer to pounds of water *per acre* in the first and second six inches respectively of the *loam* soil.
	Temperature of the air.	Temperature of the soil 3 inches deep.			Temperature of the air 6 inches above surf'ce of			Temperature of the air.	Temp. of the air 6 inches above surface of		Temperature of the air.	Minimum temperature of air 6 inches above surface of				3 P. M.	10 P.M.	7 A. M.	Miles.	Hours. Min't's rec to 7 PM	Rain to 10 P. M. Inches	
		Loam.	Red Clay.	Difference.	Loam.	Red Clay.	Difference.		Loam.	Red Clay.	Actual	Minimum.	Loam.	Red Clay.	Difference.							
Aug30-1	72.7	76.9	76 6	—0.3	82.2	77.9	4.3	66.0	58.0	59.0	56.7	51.7	49.0	48.4	0.6	55	81	97	20	11-25	- -	Soil sat'rat'd on 27th
31-1	73.8	77.6	80.1	2.5	83.0	80.1	2.9	66.6	62.2	62.2	56.1	52 8	50.1	48.6	1.5	44	92	91	15	10-40	tr'ce	
Sept. 1-2	73.0	79.0	82 4	3.0	84.5	79.4	5.1	67.3	59.3	60.7	57.8	53.3	50.0	48.5	1.5	53	82	97	15	11-05	tr'ce	
2-3	76.0	81.2	86.2	5.0	88.9	84.0	4.9	71.6	64.3	65.4	60.4	57.5	55.0	54.9	0.1	58	78	89	29	11-10	.	203,245 and 306,-
3-4	80.3	81.6	87.0	5.4	95.0	89.4	5.6	76.3	68.7	70.4	65.7	63.6	62.1	61.3	0.9	59	86	97	24	9-15	..	614 lbs. moisture
4-5	76.4	81.3	84.4	3.1	90.0	84.2	5.8	69.6	66.1	64.6	57.6	53.2	51.3	49.7	1.6	69	87	97	26	10-10	tr'ce	in soil.
5-6	71.4	76.3	77.9	1.6	83.0	79.9	3.1	68.8	62.0	63.4	58.9	54.9	50.7	51.1	—0.4	59	92	92	7	7-10	...	
6-7	77.6	84.7	89.0	4.3	88.7	87.3	1.4	73.1	71.0	69.2	65.4	62.2	60.0	60.4	—0.4	68	88	95	38	10-30	....	
7-8	82.1	82.8	85 5	2.7	93.5	90.8	2.7	76.0	72.8	73.8	70.0	68.7	66.7	66.1	0.6	58	86	88	41	8 30	..	
8-9	80.0	87.6	91.0	3.4	93.0	88.4	4.6	70.2	65.0	65.4	58.3	55.7	53.0	51.4	1.6	53	85	91	20	9-25		
9-10	76.7	86.1	90.8	4.7	91.4	88.1	3.3	75.0	65.9	67.6	63.2	61.1	58.7	58.2	0.5	64	92	95	24	9-40	....	99.232 and 203.932
10-11	83.9	88.0	92.2	4.2	97.0	94.5	2.5	78.8	74.3	76.4	66.0	65.1	62.9	62.6	0.3	62	95	98	10	10-45	...	lbs. moist. Dense
11-12	84.8	87.7	92.7	5.0	98.6	96.4	2.2	79.0	76.0	75.4	66.0	62.4	60.8	60.4	0.4	65	86	95	11	8-10		fog on 11th till 9
12-13	82.7	89.4	94.1	4.7	97.2	97.4	—0.2	76.8	73.7	73.4	70.8	67.1	65.3	64.8	0.5	65	88	95	30	9-10	..	A. M.
13-14	87.9	91.2	96.0	4.8	100.4	99.5	0.9	83.1	79.2	78.4	73.4	71.7	68.0	68.2	—0.2	60	89	91	20	10-30	....	
14-15	93.2	95.0	101.3	6.3	109.0	107.4	1.6	79.3	77.5	76.7	70.0	69.2	67.9	67.2	0.7	56	85	93	33	7-00	0.25	
15-16	84.5	86.6	90.2	3.6	95.0	94.0	1.0	78.3	77.0	76.4	67.8	66.7	65.0	64 2	0.8	66	91	88	39	5-20	tr'ce	
16-17	72.7	81.2	83.1	1.9	85.1	84.5	0.6	68.3	65.1	64.7	55.0	53.8	51.2	50.4	0.8	57	77	85	31	8-30	0.15	
17-18	69.0	77.6	79.2	1.6	76.2	74.4	1.8	62.2	60.8	59.4	58.6	56.8	56.0	55.2	0.8	61	87	89	28	7-25	...	106,912 & 170,940
18-19	70.1	72.7	74.6	1.9	77.3	74.6	2.7	66.9	64.8	64.0	63.7	62.5	61.4	60.4	1.0	79	92	92	23	0-40	...	lbs. moist. in soil.
19-20	72.8	75.8	78.0	2.2	79.8	79.1	0.7	68.2	63.9	62.7	59.1	55.8	53.8	52.4	1.4	60	92	97	17	5-20	....	

20-21	79.0	84.4	89.2	4.8	90.3	86.4	3.9	73.9	66.8	67.8	61.0	57.5	53.9	53.4	0.5	59	87	97	1	10-15	..	
21-22	79.6	85.2	90.2	5.0	90 3	89.1	1.2	72.8	65.4	67.1	66.8	62.2	59.3	59.6	—0.3	62	92	92	27	9-45	tr'ce	
22-23	83.9	84.0	89.0	5.0	93.2	92.4	0.8	73.6	69.8	78.4	66.9	54.3	64.5	63.4	1.1	66	75	85	28	6-10	..	
23-24	57.8	71.2	69.6	—1.6	57.0	56.1	0.9	54.8	52 1	51.0	47.2	45.3	41.1	40.2	0.9	94	91	62	76	0-00	0.39	Light frost, 165,036 and 174,558 lbs. moisture in soil.
24-25	56.1	66.8	67.4	0.6	65.2	63.7	1.5	49.1	43.1	43.4	39.9	37.8	35.0	33.7	1.3	50	89	88	27	9-20	...	
25-26	59.2	67.0	70.2	3.2	69.7	68.5	1.2	54.8	51.0	50.7	41.1	40.0	37.4	36.4	1.0	58	90	92	5	6-10	....	
26-27	63.1	73.0	74.4	1.4	73.5	73.4	0.1	58.8	52.4	52.6	51.1	49.5	46.8	46.7	0.1	64	94	90	10	9-00	....	
27-28	65.6	68.2	69.5	1.3	68.2	67.6	0.6	59.1	57.2	55.7	62.3	56.6	55.8	54 4	1.4	70	94	97	28	1-50	....	
28-29	72-9	67.7	69.1	1.4	76.0	76.8	—0.8	73.2	71.0	70.4	72.8	70.8	70.0	68.6	1.4	84	98	98	25	0-15	0.09	
29-30	82.6	79.0	80.3	1.3	85.0	85,3	—0.3	73.9	72.2	71.3	70.0	69.4	68.0	67.4	0.6	93	98	98	17	3-20	1.44	
30-1	79.3	81.3	81.0	—0.3	81.6	82.4	—0.8	73.9	71.0	70.6	61.5	61.0	58.1	57.7	0.4	78	95	90	102	2-00	tr'ce	
Oct. 1-2	76.2	79.0	82.2	3.2	84.9	84.4	0.5	70.0	62.9	63.7	56.8	57.0	52.2	52.6	0.6	51	80	94	31	7-50	....	215,632 & 210,149 lbs. moist. in soil.
2-3	79.5	78.8	83.7	4.9	86.0	86.3	—0.3	70.3	65.0	65.7	63.4	61.4	58.0	58.7	—0.7	51	85	87	45	9-50	..	
3-4	81.8	80.2	84.4	4.2	87.4	88.4	—1.0	71.8	69.7	69.5	53.0	52.4	49.2	48.9	0.3	54	90	88	32	8-30	....	
4-5	74.1	77.3	81.2	3.9	80.7	81.1	—0.4	64.9	59.0	58.2	49.0	47.3	41.6	41.4	0.2	35	51	70	65	9-35	..	
5-6	61.9	71.6	74.8	3.2	70.8	67.4	3.4	56.2	51.0	54.4	45.1	43.0	38.7	38.4	0.3	50	75	93	42	7-25	..	
6-7	66.8	74.0	79.4	5.4	76.8	78.0	—1.2	60.2	53.0	54.4	48.9	47.0	44.0	43 6	0.4	56	91	93	13	9-15	....	
7-8	75.1	75.5	81.2	5.7	84.2	84.0	0.2	65.8	58.8	60.4	56.6	55.6	51.0	50 6	0.4	57	91	97	24	9-15	....	
8-9	78.7	78.0	85.4	7.4	90.0	88.4	1.6	69.9	62.2	63.4	61.8	60.0	57.8	57.5	0.3	63	87	95	14	9-10	tr'ce	120,811 & 155,160 lbs. moist. in soil.
9-10	82.0	80.6	86.4	5.8	91.0	91.4	—0.4	74.2	67.0	66.6	62.0	61.0	58.9	58.2	0.7	55	78	89	38	9-00	tr'ce	
10-11	84.0	82.4	89.0	6.6	93.9	93.6	0.3	75.2	72.0	71.4	64.3	55.0	61.0	60.6	0.4	54	67	82	47	9-15	...	
11-12	75.6	79.7	81.4	1.7	77.9	77.8	0.1	55.0	54.0	53 4	44.8	44.2	40 5	40.5	0.0	67	90	93	54	3-50	..	
12-13	57.8	66.7	69.4	2.7	65.8	66.6	—0.8	52.0	45.0	44.8	39.0	37.3	34.8	34.4	0.4	51	86	84	38	8-35	0.10	Light frost in spots. None seen at thermometers.
13-14	66.4	71.1	76.6	5.5	75.4	75.9	—0.5	59.7	51.2	52.0	45.9	45.2	42.1	41.4	0.7	59	81	89	12	9-00	....	
14-15	65.0	71.2	75.6	4.4	74.0	73.6	0.4	55.0	49.0	47.4	42.3	41.0	37.4	37.1	0.3	41	74	77	18	9-00	....	
15-16	57.0	66.6	69.6	3.0	65.4	64.6	0.8	47.1	43.1	41.6	42.2	35.2	31.6	30.4	1.2	43	85	77	12	8-30	....	75,378 and 120,115 lbs. moist. in soil.
16-17	64.2	67.8	72.3	4.5	74.7	72.4	2.3	59.1	55.0	54.4	52.0	47.8	44.4	43.4	1.0	64	91	94	43	5-50	....	
Mean ..				3.5			1.5								0.6				30			

effect of soil is already well recognized by our farmers in this State, but is not understood.

It was expected that our observations on the radiation proper or loss of heat during the night would indicate generally that frost might be much more liable to occur over one soil than over the other, but no such indication is given, as the differences, as indicated by the thermometers above the two soils, are very small.

Such as they are, however, they show that contrary to what we should expect, the lowest or minimum temperature of the air over the loam is higher than the clay.

The data furnished in the table is not sufficient to warrant further discussion, and it must be accepted, as has been said, *as* data in lieu of further, more systematic and more thorough work than our time and means have allowed.

DIFFERENCE IN TEMPERATURE

BETWEEN THE LOAM SOIL OF THE COTTON FIELD AND SIMILAR SOIL CONTAINED IN A GALVANIZED IRON BOX, TWO FEET IN DIAMETER AND TWO FEET DEEP SUNK IN THE GROUND 15 FEET AWAY, AND KEPT CONSTANTLY SATURATED. THE LOAM WAS WARMER OR COLDER (—) THAN THE WET SOIL — DEGREES FAHRENHEIT.

DATE.	7 A. M.				1. P. M.				7 P. M.				Relative Humidity	Rain. Inches.	Sunsh'ne h'rs min.	Wind. Miles.
	Sur.	3 in	6 in	12in	Sur.	3 in.	6 in.	12in	Sur.	3 in.	6 in.	12in				
June 5	2.4	—0.2	—1.2	—1.0	4.4	—1.6	0.2	—0.4	1.1	2.8	1.4	0.0	75.0	.....	10.20	88
6	0.7	1.1	—0.2	—0.3	—0.9	—1.1	0.6	0.2	1.1	2.5	1.5	0.5	77.7	.....	6.45	134
7	1.2	1.1	0.2	0.1	16.3	3.1	2.8	1.1	1.2	4.0	3.6	2.2	74.0	0.03	10.15	161
8	5.0	1.0	0.3	0.7	4.2	0.6	1.1	1.1	0.1	1.4	0.6	1.2	79 7	0.78	10.40	123
9	4.6	0.8	0.0	0.2	7.1	0.1	2.3	1.0	0.1	1.1	1.0	1.2	81.0	0.35	9.40	124
10	1.1	0.1	0.0	0.5	2.1	—0.9	1.0	1.0	—0.7	0.7	0.3	1.0	83.0	0.65	6.30	153
11	—0.1	0.9	—0.9	—0.1	1.4	—0.2	0.0	0.3	—0.3	4.0	0.6	—0.6	67.3	0 02*	.....	310
12	2.9	2.9	0.7	0.3	10.8	0.9	8.4	0.8	4.5	7.1	4.7	2.0	55.0	.....	13.10	255
13	9.3	3.1	1.2	1.0	16.0	4.7	4.8	1.7	4.3	7.4	6.7	3.4	48 3	.....	13.00	213
14	5.0	2.6	2.2	1.8	24.3	4.9	5.7	2.2	7.8	9.6	7.8	4.0	54.0	.....	13.10	166
15	3.5	3.0	1.6	2.3	20.6	5.9	6.0	2.9	5.3	7.8	6.9	4.2	67.3	.....	11.30	163
16	4.2	2 6	1.5	2.1	18.1	3.3	5.3	2 5	5.0	7.0	6.5	0.9	63.3	.....	13.00	56
17	4.5	2.7	2.2	2.5	26.1	7.0	7.3	3.1	9.1	9.8	9.0	4.8	52.7	.....	12.35	133
18	7.4	4.1	2.9	2.9	27.4	7.8	8.5	4.0	8.8	9.7	8.8	5.3	57.0	.....	12.45	135
19	6.5	3.2	2.5	2.6	30.6	8.1	8.0	3.2	8.8	11.2	9.5	5.3	54.7	.....	13,10	116
20	7.5	3.6	3.0	3.4	32.5	7.6	8.5	3.5	10.6	10.2	8.8	4.8	59.3	0.07	12.40	111
21	5.9	3.2	2.0	2 9	26.0	6.2	6.9	3.1	9.8	10.1	8.2	4.8	66.0	.....	10.15	146
22	7.6	4.3	3.3	3.6	14.2	4.0	4.8	3.0	0.3	3.5	2.1	2.8	84.3	0.29	0.00	216
23	—0.8	1.6	—0.1	1.6	**1.1	0.0	0.0	1.2	1.0	0.5	0.4	0.7	89.7	2.87	6.35	134
24	1.1	1.3	0.0	1.0	2.6	—2.2	1.0	0.5	0 3	1.2	0.8	1.0	85.7	0.02	5.30	50
25	—0.7	2.1	0.1	0.8	.....	—2.2	0.4	1.0	.....	1.6	0.5	0.8	72.0	.....	6.30	155
Mean.....	3.8	2.1	1.0	1.4	14.3	2.8	4.0	1.8	3.9	5.5	4.3	2.3				

HOURLY READINGS JUNE 18—IN THE LOAM SOIL.

HOUR.	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	Me'n
Air.	75.4	76.2	82.1	85.0	88.0	91.4	91.7	93.4	94.5	94.4	95.2	95.2	92.0	89.8	85.0	83.0	87.8
Surface..	72.0	79.3	89.3	97.5	117.1	115.5	118.3	120.6	118.1	115.2	109.5	100.9	94.3	87.3	82.3	79.5	98.4
3 inches	73.2	74.0	76.2	78.9	82.7	87.2	89.4	92.3	94.0	94.9	94.8	93.6	91.7	89.7	87.5	85.2	86.6
6 inches	74.7	74.5	75.2	76.6	79.1	82 9	84.7	87.4	89.7	91.0	91.6	91.6	90.7	89.6	88.1	86.4	84.6
12 inches	76.5	76.1	75.9	75.8	76.0	76.8	77.1	78.0	79.0	80.0	81.0	81.9	82.3	82.6	82.6	82.6	79.0

IN THE SATURATED SOIL.

Surface..	66.7	71.9	78.4	81.2	85.8	88.7	91.6	93.2	90.2	87.2	83.7	80.4	80.2	78.2	76.4	75.4	81.2
3 inches	68.4	69.9	72.9	75.0	78.1	81.2	82.6	84 5	84.8	84.3	83.8	82.5	80.9	80.0	78.9	77.9	79.1
6 inches	71.7	71.6	71.9	72.9	74.3	76.2	77.2	78.9	80.3	81.2	81 7	81.8	81.4	80.8	80.2	79.6	77.8
12 inches	73.6	73.2	72.9	72.9	72.9	73.3	73.6	74.0	74.8	75.4	76.1	76.8	77.1	77.3	77.7	77.5	75.0

DIFFERENCE—THE LOAM WAS WARMER THAN THE SATURATED SOIL.

Surface..	5.3	7.4	10.9	16.3	31.3	26.8	26.7	27.4	27.9	28.0	25.8	20.5	14.1	9.1	5.9	4.1	17.2
3 inches	4.8	4.1	3.3	3.9	4.6	6.0	6.8	7.8	9.2	10.6	11.0	11.1	10.8	9.7	8.6	7.8	7.5
6 inches	3.0	3.9	3.3	3.7	4.8	6.7	7.5	8.5	9.4	9.8	9.9	9.8	9.3	8.8	7.9	6.8	6.8
12 inches	2.9	2.9	3.0	2.9	3.1	3.5	3.5	4.0	4.2	4.6	4.9	5.1	5.2	5.3	4.9	5.1	4.0

*Record lost—partly cloudy.

**No water added to the soil in the iron box after this.

TEMPERATURE OF A STIFF RED CLAY SOIL ABOUT 70 FEET FROM THE LOAM, IN THE SAME COTTON FIELD, NEAR WHERE SAMPLE XL WAS TAKEN. (See Moisture Determination, May 5, Page 189.)

DATE.		7 A. M.				1 P. M.				7 P. M.				RAIN inchs
		Sur.	3 in.	6 in.	12 in	Sur.	3 in.	6 in.	12 in	Sur.	3 in.	6 in.	12 in	
July	31	77.2	77.2	78.0	79 7	84.9	87.2	83.7	79 7	78.2	81.2	81.8	80.4	0.19
August	1	78.2	77.2	77.7	79.2	99.6	88.2	84.0	79.3	.....	.....	.....	.....	0.30
	2	79.2	76.8	77.7	79.6	84.1	82.6	80 8	79.0	74.7	78.4	79.9	80.3	1.27
	3	76.6	76.4	77.0	79.4	83.4	80.0	78.5	78.1	78.3	81.4	81.0	78.6	0.68
	4	75.2	76.2	76.8	78.0	81.4	80.2	79.2	77.8	75.4	80.4	86.0	78.6	0.24
	5	75.1	75.1	76.0	77.8	100.9	81.2	81.9	77 8	79.4	81.4	84.6	79.6	0.01
	6	78.8	76.8	77.7	79.1	102	90.2	84 2	79.0	75.1	83 2	85.4	80.6	0.71
Mean for Clay...		77.2	76.5	77.3	79 0	90.9	84.2	81.8	78.7	76.9	81.5	83.1	79.7	.....
Mean for Loam..		76.6	76.6	77.2	78.5	89.6	84.6	82.3	78.9	77.4	81.2	82.3	80.5	.....
Difference		0.6	—0.1	0.1	0.5	1.3	—0.4	—0 5	—0.2	—0.5	0.3	0.8	—0.8	.....
August	7	71.8	75.4	76.9	79.2	91.2	82.6	79.1	78.4	74.2	79.2	80.6	79.0	0.02
	8	69.4	72.1	74.0	77.5	74.8	76 3	75.7	76.7	71.4	75.9	76.8	76.8	0.22
	9	68.4	66.9	69.7	75.1	97.7	85.2	77.8	74.8	71.3	79.7	80.2	76.7	trace.
	10	71.4	68 1	70.4	75 3	100.3	87.8	80 5	75.3	76.4	84.2	84.1	77.7	trace.
	11	73.6	71.4	73.7	77.0	107.2	91.5	83.2	76.8	79.2	87.2	87.0	79.0	trace.
	12	79.2	74.5	76.3	78.5	113.2	96.3	86.9	78.5	81.5	90.0	89.6	81.0	trace.
	13	80.2	77.6	79.1	80.6	100.2	91.3	86.0	80.2	76.4	85.0	85.7	81.5	.....
Mean for Clay...		73.4	72.3	74.9	77.6	97.8	87.0	81.3	77.2	75.8	83.0	83.1	78.8	.....
Mean for Loam..		71.7	72.9	74.2	77.1	96.2	85.3	81.7	77.2	76.6	82.3	83.1	80.1	.....
Difference		1.7	—0.6	0.7	0.5	1.6	1.7	—0.4	0.0	—0.8	0.7	0.3	—1.3	.....
August	14	75.4	76.9	78 2	80.0	103.9	85.4	81.0	79.3	78.7	87.2	87.0	80.8	1.05
	15	71.4	74.4	76.0	79.0	88.2	85.1	81.5	78.5	80.2	83.7	83.5	79.8	0.03
	16	73.2	73.5	75.7	78.9	100.3	89.1	83.8	78.5	76.4	84.4	85.0	80.2	0.12
	17	72.7	75.0	76.5	79.0	106.1	90.2	83.8	78.6	79.2	84.2	84.7	80.2	0.71
	18	76.5	73.4	75.2	78.5	93.6	85.8	82 0	78.2	78.2	81.0	82.1	79.6	0.13
	19	76.5	76.6	76.7	78 6	94.7	88.2	83.0	78.3	78.2	82.1	82.7	79 7	0.18
	20	75.4	75.4	76.5	78.5	101.9	90.2	84.0	78.6	80.9	85.2	86.0	80.5	.....
Mean for Clay...		74.7	75.0	76.4	78.9	98 4	87.7	82.7	78.6	78.8	83.9	84.4	80.1	... .
Mean for Loam..		75.2	75.3	76.3	78.5	97.8	86.3	83.2	78.8	78.7	83.6	84.4	81.5	.....
Difference.		—0.5	—0.3	0.1	0.4	0.6	1.4	—0.5	—0.2	0.1	0.3	0.0	—1.4	.....
August	21	76.4	74 6	76.3	79.3	104.2	92.4	85.2	79.3	78.2	85.2	86.7	81.2	trace.
	22	78.2	76.5	77.8	79.8	102.5	93.2	86.0	79.7	80.0	85.4	86.5	81.6	trace.
	23	77.6	76.8	78.2	80.1	106.2	92.4	86.6	80.0	77.6	84.2	86.6	82.0	0.17
	24	72.4	74.4	76.6	79.8	94.3	85.4	80.9	79 0	78.2	83.2	84.1	80.2	0.01
	25	68.7	70.6	74.2	78.8	102.4	90.2	82.0	78.0	72.6	82.8	84.4	80.0	.....
	26	65.5	66.5	70.4	77.3	94.2	83.4	78.2	76.3	72.4	80.0	81.4	78.0	.....
	27	64.7	67.5	71.2	76.0	68.0	68.9	70.9	74.9	64.0	68.4	70.7	74.0	4.16
Mean for Clay...		71.9	72.4	74.9	78.9	96.0	86.6	81.4	78.2	74.7	81.3	82.9	79.6	.....
Mean for Loam..		71.0	73 4	75.1	78.5	97.2	85.2	82.1	78.3	74.4	81.9	83.3	81.0	.....
Difference.....		0.9	—1.0	—0.2	0.2	—1.2	1.4	—0.7	—0.1	0.3	—0.6	—0.4	—1.4	.....
August	28	63.7	65.0	67.2	72.3	87.2	75.9	71.6	72.0	68.3	73.4	74.4	73.3	0.02
	29	62.5	64.8	67.3	72.3	86.4	78.4	73.5	71.9	64.9	70.3	73.2	73.2	0.77
	30	60.7	59.7	63.3	71 0	90.2	78.6	71.3	70.5	63.5	71.1	72.6	72.0	.....
	31	61.1	59.8	63.2	70.2	92.2	80.1	72.9	70.0	64.5	73.3	74.3	71.9	trace.
September	1	61.3	59.2	63.6	70.2	96.0	82.4	73.6	70 0	65 5	75.2	75.8	72.2	trace.
	2	62.4	61.4	64.6	70.7	103.0	86.2	76.4	70.6	69 4	78.4	79.3	73.4	.....
	3	64.2	63.5	66.8	72.0	106.2	87.0	78.0	71.6	73.4	81.2	81.2	74.6	.....
Mean for Clay...		62.3	61.9	65.1	71.2	94.5	80.9	73.9	70.9	67.1	74.7	75.8	73.0	.....
Mean for Loam..		59.8	63.6	65.5	70 1	94.0	78 6	74.7	70 6	66.8	75.1	76.2	74.1	.....
Difference		2.5	—1.7	—0.4	1.1	0.5	2.3	—0.8	0.3	0.4	—0.4	—0.4	—1.1	.....

TEMPERATURE OF THE SOILS—CONTINUED.

DATE.	7 A. M.				1 P. M.				7 P. M.				RAIN.
	Sur.	3 in.	6 in.	12in	Sur.	3 in.	6 in.	12in	Sur.	3 in.	6 in.	12in	Inchs
September 4	67.5	68.4	70.7	73.8	97.2	84.4	77.4	73.4	68.5	77.4	78.6	75.1	trace.
5	62.5	63.4	66.7	72.9	94.3	77.9	73.7	72.2	66.5	74.4	76.0	73.5	.....
6	62.5	62 5	65.4	71.6	97.4	89.0	79.0	71.5	71.4	80.2	81.1	74.6	.....
7	68.4	66.7	69 4	73.3	100.4	85.5	78.9	73.1	75.2	80.4	80.9	75.3	.....
8	71.2	71.2	72.7	74.7	100.4	91.0	81.9	74.9	69 3	81.2	82.6	77.0	.....
9	63.6	64.3	69.0	74.8	104.2	90.8	80.8	74.0	71.2	82.1	82.9	76.8	.....
10	69.0	67.5	70.6	75.0	110.2	92.2	82.4	74.7	77.4	85 2	85.2	77.5	.....
Mean for Clay...	66.4	66.3	69.2	73 7	100.6	87.4	79.2	73.4	71.4	80.1	81.0	75.7	.....
Mean for Loam..	68.1	67.2	68.9	73.0	104.6	83.8	79.6	73.5	71.1	80.0	81.1	77.1	.....
Difference	—1.7	—0.9	0.3	0.7	—4.0	3.6	—0.4	—0.1	0.3	0.1	—0.1	—1.4	.....
September 11	70.4	71.4	73 8	76.7	110 2	92.7	84.4	76.4	77.7	86.0	86 4	79.1	.....
12	73.1	71.4	73.9	77.3	108.2	94.1	85.1	77.0	76 7	85.2	86.3	79.7	.....
13	75.4	72.7	75.0	78.0	114.2	89.0	86.7	78.0	81.2	89.9	88.7	80.9	.....
14	78.2	76.1	77.9	79 7	126.2	101.3	90.7	79.8	79 5	85 4	86.9	82.4	0.25
15	72.5	74.4	76.8	79.8	101.2	90.2	83.3	79.0	79.2	83.2	84.2	80.6	trace.
16	70.4	71.4	75.6	78 9	94.2	83.1	78.7	77.8	66.5	76.4	78.8	78.3	0.15
17	59 5	63.3	67.4	75.1	84.9	79.2	74.4	74.0	63.2	71 8	74.3	75.0	.....
Mean for Clay...	71.4	71.5	74 3	77 9	105.6	89.9	83.3	77.4	74.9	82.6	83.7	79.4	.....
Mean for Loam..	69.5	72.2	73.9	77.3	105.5	86.9	82.8	77.4	75.0	82 6	83.5	80.4	.....
Difference.....	1.9	—0.7	0.5	0.6	0.1	3.0	0.5	0.0	—0.1	0.0	0.2	—1.0	.....
September 18	60.7	63.8	67.0	72.8	85.4	74.6	70.6	72.0	67 5	71.6	72.7	72.8	.....
19	64.6	66.7	68.6	72.0	89.2	78.0	72.8	71.8	66.7	75.2	75.9	73.3	.....
20	66.3	63.1	66.3	72.1	103.2	89 2	78.8	72 1	69.6	79.6	80.3	75.0	.....
21	68.4	64.5	68.2	73.6	104 9	90.2	80.9	73.3	70.4	80.4	81.4	76.2	trace.
22	67.5	69.0	71.3	74 5	108.2	89.0	79.6	74.2	71.6	80.4	81.3	76.5	.....
23	66.3	70.4	72.4	75.2	60.5	69.6	72.6	74.3	55.4	62.8	67.1	73.0	0.39
24	57.4	53.4	59.3	69.2	76 6	67.4	64.0	67.7	49.5	60.0	63.7	68.1	.....
Mean for Clay...	64.5	64.4	67.6	72.8	89.7	79.7	74.2	72 2	64.1	72.9	74.6	73.6	.....
Mean for Loam..	60 8	65.8	67.6	71.7	90.5	77.1	74.2	71.6	64.8	73.9	75.1	74.1	.....
Difference.....	3.7	—1.4	0.0	1.1	—0.8	2.6	0.0	0.6	—0 4	—1.0	—0.5	—0 5	.....
September 25	43.2	48.7	54.0	65.0	85.0	70.2	63.7	64.1	55.1	64.0	65.6	65.9	.....
26	45.3	50.9	55.4	64.3	92.1	74.4	66.4	64.0	56 5	66.7	68.4	66.3	.....
27	55.5	56.6	59.6	65.4	75.4	69.5	66.4	65.1	59.3	62.8	64.7	66.2	.....
28	61.5	61.8	62.8	65.6	78.2	69.1	66.7	65.8	70.2	69 7	69.7	67.2	0.09
29	72.4	69.7	69.2	68.4	88.2	80.3	75.1	69.4	73.3	75.6	75.3	71.2	1.44
30	70 4	70.4	71.4	71.4	85.8	81.0	77.8	71.9	72.4	75.1	75.8	73.2	trace.
October 1	61.5	65.2	68.1	71.8	90.8	82.2	75 3	71.2	63.7	72.5	74.7	72.8	.....
Mean for Clay...	58.5	60.5	62.9	67.4	84.8	75.2	70.2	67.4	64.4	69.5	70.6	69.0	.....
Mean for Loam..	57.7	61.4	62.7	66.2	84.7	73.6	70.0	66.7	64.4	70.0	70.6	69.3	.....
Difference	1.2	—0.9	0.2	1.2	0.1	1.6	0.2	0.7	0.0	—0.5	0.0	—0.3	.....
October 2	62.3	60.5	64.2	70.2	95.4	83.7	75.3	69.8	66.7	73.4	75 7	72.0	.....
3	66.5	63.3	66.3	70.5	97.4	84.4	76.7	70.4	71 1	76.2	77.3	72.7	.....
4	56.8	59.5	64.7	70.7	92.0	81.2	74.2	70 0	60.3	70 6	73.8	71.7	.....
5	53.3	54.7	60.7	68.7	79.2	74.8	68 9	67.5	53.9	68.0	69.0	68.9	.....
6	51.5	52.5	57.8	66.3	95.2	79.4	69.8	65.7	56.6	68.3	70.7	68.0	.....
7	55.3	55.0	59.6	66.3	96.5	81.2	71.2	66.0	61.5	61.2	72.9	68.7	.....
8	58.8	58.8	62 6	67.6	101.9	85.4	74.9	67.5	65.4	74.3	75.8	70.3	trace.
Mean for Clay...	57.8	57.8	62.3	68.6	94.3	81.4	73.0	68.1	62.2	71.7	73.6	70 3	.....
Mean for Loam..	52.0	59.7	62.0	65.9	97.0	76.5	72.5	68.0	62.7	72.5	73.4	71.1	.....
Difference.....	5.8	—1.9	0.3	2.7	—3.7	4.9	0.5	0.1	—0.5	—0.8	0.2	—0.8	.....

TEMPERATURE OF THE SOILS—CONTINUED.

DATE.	7 A. M.				1 P. M.				7 P. M.				RAIN Inches
	Sur.	3 in.	6 in.	12in	Sur.	3 in.	6 in.	12in	Sur.	3 in.	6 in	12 in	
October 9	63.0	63.0	65 8	69 3	104.0	86.4	76.5	69.3	68.4	76.4	77.7	72.1	trace.
10	65 2	64.3	67.4	70.9	101.4	89.0	78.3	70.7	70.9	78.2	79.3	73.4	.....
11	67.5	66.5	69.2	72.0	82.2	81.4	77.6	71.7	54.3	67.7	71.9	72.8	.....
12	46.9	54.1	60.1	68.8	75.0	69.4	64.9	67.2	47.1	61.5	65.1	67.7	0.10
13	42.3	49.0	54.9	64.7	86.2	76.6	66.6	64.0	53.5	65.7	68.1	66.1	.....
14	48.5	51.8	57.0	57.0	64.8	82.7	75.6	66.4	49.5	63.5	66.8	65.9	.....
15	39.3	48.6	54.8	63.7	73.1	69.6	62.3	62.6	42.1	58 5	62.2	63.9	.....
Mean for Clay ...	53.2	56.8	61.3	67.7	86.4	78.3	70.4	67.1	55.1	67.4	70.2	68.8	.....
Mean for Loam..	51.9	58.7	61.0	66.1	91.0	74.0	69.5	66.3	58.3	69.1	70.4	69.4	.....
Difference.....	1.3	—1.9	0.3	1.6	—4.6	4 3	0.9	0.8	—3.2	—1.7	—0.2	—0.6	.....
October 16	43.8	48.7	52.8	61.2	82.2	72.3	62.5	60.7	56.6	64.5	65.3	63.0	.....
17	51 5	55.9	58.2	62.9	82.8	77.7	68.1	62.9	65.5	69.6	70.0	65.6	.....
18	60.3	62.5	64.1	65.9	64.5	64.3	64.1	65.3	61.5	62.8	64.0	65.3	1.26
19	60.3	61.5	62.7	64.8	67.7	65.5	64.0	64.6	60.6	63.3	64.4	65.0	0.18
20	58.6	60.5	62.0	64.5	62.3	62.0	62.1	64.0	57.7	60.6	62.2	63.4	1.19
21	52.7	56.6	58.6	63.0	68.6	67.0	63.4	62.9	44.3	54.8	59.3	63.2	.....
22	35.2	43.5	49.4	59.7	68.4	62.5	57.0	58.6	45.1	54.8	57.4	59.7	.....
Mean for Clay...	51.8	55.6	58 3	63.1	70.9	67.3	63.0	62.7	55 9	61.3	63.2	63.6	.....
Mean for Loam..	52.5	57.3	58.4	61.9	73.0	65.5	63.4	62.0	56.6	62.8	63.6	63.7	.....
Difference.....	—0.7	—1.7	—0.1	1.2	—2.1	1.8	—0.4	0.7	—0.7	—0.5	—0.4	—0.1	.....
October 23	36.3	44.2	49.2	57.9	73.4	64.5	58.5	57.3	55.3	57.6	58.7	58.9	.....
24	55.5	55.2	56.2	59.1	73.4	66.5	62.7	59.7	61.5	62.4	62.9	61.2	0.10
25	45.3	52.6	56.3	61.0	44.3	50.6	53.8	59 8	44.3	47.5	51.5	58.3	0.78
26	42 6	45.5	48.9	55.5	47.6	48.7	49.5	54.8	45.3	47.5	49.9	54.6	1.68
27	46.1	47.9	50.0	54.0	52.5	52.4	52.2	55.0	49.5	50.4	52.0	55.3	0.48
28	50.5	50.6	52 2	55.6	56 5	55.6	54.7	56.0	53.3	54.6	55.3	56.7	0.19
29	52.5	53 6	54 6	56.8	59.0	57.4	56.0	56.8	55.5	56.6	57.0	57.3	... ...
Mean for Clay...	47.0	49.9	52.2	57.4	58.1	56.5	55 3	57.1	52.1	53.8	55.4	57.2	.....
Mean for Loam..	49.3	51.8	52.8	57.4	58.9	56.3	55.5	55.9	54.4	55.1	55 6	56.8	.....
Difference.....	—2.3	—1.9	—0.6	0.0	0.8	0.2	—0.2	1.2	—2.3	—1.3	—0.2	0.7	.....
October 30	51.5	53.6	54.9	57.3	50.5	53.7	55.1	57.1	45.3	49.6	52.4	56.8	0.07
31	35.3	38.7	45.4	54.0	35.3	40.7	44.2	52.0	....	....	....	....	4.18
November 1	37.3	38 3	41.0	48.3	62.5	54.5	48.1	49.1	41.7	47.3	49 7	51.3	0.34
2	31.3	36.7	41.9	50.2	61.3	58.5	50.7	49.8	42.6	49.1	52.0	51.9	.....
3	35.3	41.1	44.0	51.0	75 4	63.5	55.0	50.8	49.8	54.4	55.7	53.3	.....
4	40.3	44.5	48.0	53.0	72.4	60 9	55.6	52.7	54.5	54.7	56.0	54.4	.....
5	35.8	44.2	48.7	53.8	63.8	58.5	52.3	53.0	41.1	50.6	53.0	53.9	.....
Mean for Clay...	38.1	42.4	46.3	52.5	60.2	55.8	51.5	52.1	45.1	51.0	53.1	53.6	.....
Mean for Loam..	40.8	46.2	47.6	51.6	64.0	54.0	52.2	51.5	45.2	51.7	52.6	53.3	.....
Difference.....	—2.7	—3.8	—1.3	0.9	—3 8	0.8	—0.7	0.8	—0.1	—0.7	0 5	0.3	.....
November 6	30.8	39.8	44.0	51.8	67.3	58.4	51.8	51.0	42.4	50.3	52.5	52.6	trace.
7	34.3	40.7	44.9	51 3	62.2	53.3	50 8	50.9	50.3	51.4	52.1	52.0	.....
8	53 9	52.1	52 0	52.9	63.9	59.4	56.1	53.6	54 5	57.4	58.0	55.1	0.12
9	43.3	48 7	51.7	50.8	58.5	55.3	53.0	54.2	45.3	50.6	52.9	54.3	0.02
10	47.1	48.1	50.0	53.2	51.1	52.1	52.3	53.1	45.3	49.8	51.9	53.4	0.54
11	56.1	39.1	43.6	51.6	58.5	52.7	49.4	50.6	40.1	46.0	49.1	51.5	.....
12	30.1	36.3	41.4	49.6	59.5	53.3	48.0	48.9	37.0	44.6	48 0	50.0	.....
Mean for Clay...	39.4	43.5	46.8	51.6	60.1	54.9	51.6	51.8	45.0	50.0	52.1	52.7	.....
Mean for Loam..	41.4	45.8	47.0	50.9	61.4	53.7	51.8	50.8	45 5	51.8	52.4	52.6	.....
Difference.....	—2.0	—2.3	—0.2	0.7	—1.3	1.2	—0.2	1.0	—0.5	—1.8	—0.3	0.1	.....

TEMPERATURE OF SOILS—CONCLUDED.

DATE.		7 A. M.				1 P. M.				7 P. M.				RAIN
		Sur.	3 in	6 in.	12 in	Sur.	3 in.	6 in.	12 in	Sur.	3 in.	6 in.	12 in	Inchs
November	13	28.3	35.5	40.0	48.2	64.5	55.3	48.7	48.0	41.5	47.2	49.0	49.4	.....
	14	36.4	39.7	43.3	48.8	59.5	52.5	48.4	48.4	49.5	49.8	50.6	50.0	0.11
	15	45.3	47.7	49.1	50.7	64.5	56.6	52.0	51.0	40.6	46.3	50.3	51.8	0.02
	16	34.3	39.3	43.1	49.8	69.5	58.4	51.0	49.2	45.6	50.4	52.0	51.0	.....
	17	45.3	46.5	47.7	50.8	69.9	60.5	54.3	50.9	51.5	53.4	54.2	52.4	.....
	18	35.0	41.3	45.7	51.3	48.5	47.3	47.1	50.1	44.3	44.7	47.0	50.0	.....
	19	40 0	42.7	45.3	49.3	45.3	45.7	46.7	49.0	40.1	44.2	46.8	49.2	0.02
Mean for Clay...		37.4	41.7	44.9	49.8	60.2	53.8	49.7	49.5	44.7	48.0	49.6	51.9	.....
Mean for Loam..		38.9	43.6	44.6	48.2	62.0	52.0	49.7	48.3	44.7	49.4	49.8	50.0	.....
Difference.....		—1.5	—1.9	0.3	1.6	—1.8	1.8	0.0	1 2	0.0	—1.4	—0.2	1.9	.....
November	20	30.1	38.5	43.5	48.8	51.3	48.5	45.6	48.0	28.0	40.0	43.8	48.2	.....
	21	22.0	31.0	36.8	45.4	53.5	45.3	40.3	44.2	29.3	38.7	41.7	45.0	.....
	22	25.1	30.5	36.1	43.6	61.5	49.4	43.3	43.3	36.3	42.3	44.9	45.0	.....
	23	31.0	35.5	39.0	44.6	66.7	52 1	46.0	44 5	46.3	48.6	48.7	47.0	.....
	24	36.3	41.5	44.2	47.2	74.6	59.7	52.2	47.6	48.5	52.4	52.7	49.7	.....
	25	38.3	43.4	46.1	49.5	77.1	62.5	54.2	49.4	52.3	55.6	56.0	51.8	.....
	26	53 5	52.8	53.0	52.3	76.4	64.1	57.6	52.9	55.5	58.5	58.7	54.3	.....
Mean for Clay...		33.8	39.0	42.7	47.3	65.9	54.5	48 4	47.1	42.3	48.0	49.5	48.7	.....
Mean for Loam..		34.4	41.1	42.4	45.5	64.3	51.2	48.0	45.7	44.6	48.1	48.4	48.3	.....
Difference.....		—0.6	—2.1	0.3	1.8	1.6	3.3	0.4	1.4	—2.3	—0.1	1.1	0.4	.....

TEMPERATURE OF THE AIR AND SOIL—MAY.

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	57.7	....	52.0	53.8	56.8	...	...	73.2	....	72.1	62.8	57.4	....	..	72.8	....	69.0	67.5	62.2	...	....
2	56 3	...	55.6	57.3	59.3	..	...	82.8	...	77.0	66.7	60.2	...	.	77.4	...	73.8	72.2	64.7	...	....
3	61.8	...	60.6	61.5	62.7	....	...	84.2	....	80.3	70.2	63.5	..	....	80.2	...	77.8	75.0	68.0	...	....
4	64.8	....	63.4	64.2	65.0	...	...	85.2	....	81.7	72.9	66.0	....	...	79.5	...	78.2	76.3	70.0	...	....
5	63.4	64.4	65.0	66.1	67.1	..	..	81.3	106.6	81.8	72.9	67.2	...	....	76.0	74.3	77.3	76.0	70.7	...	...
6	65.7	66.3	66.0	67.0	67.6	....	...	77.2	93.8	77.0	70.8	67.2	....	...	69.6	68.9	71.6	71.3	69.2	..	...
7	65.8	66.3	65.3	65.3	66.2	....	...	79.5	85.3	78.0	71.0	67.0	...	....	72.8	68.1	70.6	70.9	68.1	63.9	57.8
8	65.0	65.8	65.0	65.0	66.0	63.9	57.0	74.9	82.3	75.9	71.8	66.9	63.9	57.2	74.2	69.2	72.6	72.6	69.4	63.9	57.4
9	63.0	65.0	64.9	65.0	66.2	64.3	57.4	70.0	85.3	70.2	67.6	66.2	64.3	57.5	72.9	68.3	71.1	71.2	68.5	64.1	57.7
10	65.0	66.0	65.6	65.5	66.2	64.4	57.7	65.5	74.3	67.5	66.9	66.2	64.1	57.7	65.8	65.0	68.4	68.9	67.3	64.0	57.8
11	65.0	66.7	65.9	65.2	65.6	64.2	58.0	74.3	89.3	75.6	71.3	67.1	64.1	58.3	72.3	68.2	73.2	73.6	70.0	64.2	58.4
12	61.1	66.7	64.8	65.0	66.9	64.9	58.4	74.8	91.5	78.9	73.7	68.1	65.0	58.6	73.5	71.5	75.2	75.5	71.2	64.9	58.7
13	66.7	70.4	67.1	67.0	68.2	65.5	58.7	81.4	91.3	79.9	75.5	69.7	65.8	59.0	71.1	69.5	72.8	73.1	71.2	65.8	59.0
14	58.0	58.6	61.7	63.7	67.0	65.9	59.0	69.8	84.3	72.0	68.3	66.5	65.9	59.2	63.5	59.6	68.0	69.7	68.3	65.5	59.2
15	51.4	53.9	55.0	57.0	62.3	64.0	59.2	70.1	91.3	73.6	67.9	63.3	64.5	59.6	69.8	64.3	71.3	72.0	67.6	64.1	59.6
16	58.0	56.9	57.8	59.1	63.1	64.2	59.5	78.2	94.3	75.4	69.8	64.1	64.1	59.8	74.6	68.7	73.9	74.0	69.0	64.0	59.9
17	60.0	59.3	60.7	61.8	65.0	64.5	59.6	82.7	98.8	78.5	72.7	66.2	64.8	60.0	80.5	77.5	76.9	76.8	71.0	64.5	60.0
18	64.0	63.8	63.5	64.3	67.0	65.5	59.9	86.0	104.5	82.5	76.0	68.4	65.6	60.2	84.2	78.2	81.0	80.8	73.7	65.7	60.3
19	68.1	67.5	67.8	68.4	70.4	66.8	60.0	85.8	103.3	83.5	78.2	71.3	67.2	60.4	77.0	73.5	78.5	79.2	75.0	67.1	60.4
20	64.9	65.8	66.8	67.9	70.3	67.9	60.3	81.3	94.3	81.6	76.1	70.9	68.0	60.7	77.2	76.4	79.8	79.8	74.6	68.0	60.8
21	67.0	69.5	68.5	69.0	70.9	68.4	60.8	79.6	98.3	83.9	78.0	71.5	68.5	61.2	77.0	75.4	80.0	80.5	75.5	68.5	61.2
22	61.0	63.6	65.8	67.5	70.8	68.9	61.1	74.2	75.3	74.8	72.5	70.3	69.8	61.4	74.0	73.5	75.8	75.8	73.0	68.5	61.5
23	65.7	67.6	67.9	68.7	70.1	68.5	61.5	74.0	87.3	72.5	70.6	69.6	68.4	61.8	69.8	67.9	71.3	72.0	71.0	68.0	61.8
24	66.6	69.5	67.8	67.8	68.8	68.0	61.9	78.5	86.8	79.8	75.8	70.5	68.0	62.1	70.0	70.0	73.1	73.7	72.2	67.6	62.0
25	64.9	68.5	65.7	66.2	68.8	68.0	62.0	80.7	88.2	81.6	76.6	70.5	68.0	62.4	80.0	74.5	77.1	77.3	74.0	68.0	62.4
26	64.0	67.8	66.0	67.0	69.8	68.5	62.3	77.4	89.8	78.5	74.8	70.7	68.5	62.5	70.5	70.5	74.5	75.0	73.0	68.5	62.5
27	62.7	62.7	64.0	65.0	68.6	68.5	62.4	73.7	87.1	76.7	73.2	69.7	68.5	62.5	70.2	66.8	72.2	73.1	71.4	68.1	62.5
28	60.8	61.8	61.0	62.7	67.0	68.0	62.5	72.5	96.3	73.5	70.2	67.4	67.8	62.8	69.8	65.8	72.1	73.0	70.2	67.4	62.8
29	60.1	63.9	61.2	62.2	66.1	67.4	62.7	74.8	94.3	78.6	73.0	67.8	67.2	62.9	74.1	71.5	77.3	77.8	72.2	67.1	62.9
30	61.2	63.3	64.0	64.9	67.0	67.7	62.7	77.8	96.3	77.5	73.0	68.8	67.8	63.0	69.2	68.5	72.4	72.8	70.7	67.5	63.0
31	64.3	64.7	65.9	66.5	68.0	67.5	62.8	65.1	67.2	67.7	67.6	67.7	67.4	62.9	67.2	68.6	68.2	68.0	67.9	67.3	62.9
Mean	62.7	64.7	63.6	64.4	66.6	66.5	60.3	77.0	90.3	77.0	71.9	67.4	66.5	60.6	73.6	70.2	74.0	74.0	70.3	66.2	60.5

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	64.8	65.8	64.8	64.9	66.7	67.0	62.9	79.7	94.3	80.7	74.5	68.2	67.0	63.0	68.9	69.3	72.7	72.8	71.0	66.8	63.0
2	60.9	63.8	64.7	65.7	65.9	67.2	62.9	75.9	80.0	74.0	71.4	68.4	67.4	63.0	76.0	70.0	72.7	72.8	70.5	67.3	63.0
3	69.0	71.8	66.9	66.8	68.3	67.5	63.0	79.7	88.2	77.0	73.2	69.6	67.5	63.0	78.1	73.5	76.0	75.4	72.0	67.5	63.1
4	68.1	79.7	67.3	68.0	69.7	68.0	63.0	81.3	96.3	80.6	76.1	71.1	68.2	63.3	80.0	74.5	77.8	77.7	73.8	67.0	63.3
5	69.4	71.8	68.0	68.3	70.4	68.9	63.3	84.0	97.3	82 5	78.0	72.0	68.0	63.5	79.0	75.5	79.7	79.2	75.0	69.0	63.5
6	66.0	68.2	69.0	69.8	71.5	69.5	63.5	80.2	92.3	80.7	76.8	72.2	69.6	63.7	79.0	75.5	78.4	78.5	75.0	69.6	63.7
7	70.2	69.6	69.8	70.0	71.8	70.0	63.7	86.0	105.5	85.0	79.5	73.1	70.0	64.0	75.2	75.7	79.7	80.6	77.0	70.0	64.0
8	71.5	75.6	72.1	72.2	73.4	70.8	64.0	83.0	94.4	82.6	79.0	74.6	70.9	64.3	74.8	76.5	79.3	80.3	77.2	70.9	64.3
9	73.2	76.5	71.7	71.7	73.2	71.4	64.4	87.0	98.4	85.0	81.5	75.0	71.5	64.5	78.2	77.5	79.0	79.8	77.3	71.4	64.5
10	73.0	74.5	73.0	73.0	74.0	71.7	64.5	83.7	91.3	84.9	81.0	75.7	71.9	65.0	*72.8	73.5	77.6	78.9	77.6	71.8	64.9
11	58.8	60.8	65.8	67.9	72.0	72.0	64.8	68.0	78.8	70.2	69.2	70.5	71.5	65.0	64.8	60.6	69.0	70.3	70.2	71.0	65.0
12	55.5	58.4	57.8	59.7	65.5	69.9	65.0	71.5	87.2	72.0	69.1	66.1	69.4	65.2	70.4	65.8	72.0	72.7	70.0	68.6	65.3
13	58.5	58.8	58.0	59.8	65.0	68.5	65.0	79.6	95.3	76.7	72.0	66.4	68.2	65.4	76.2	70.7	76.0	76.4	71.4	67.9	65.4
14	67.7	68.3	64.5	65.0	68.0	68.4	65.1	86.8	109.0	83.8	78.5	70.2	68.5	65.4	81.8	76.3	81.5	81.7	75.1	68.5	65.2
15	61.5	66.0	65.8	67.2	70.8	69.5	65.0	80.3	102.8	82.8	78.5	71.9	69.6	65.3	74.5	73.8	79.7	80.8	76.2	69.6	65.1
16	63.0	68.7	65.5	66.5	70.8	70.4	65.0	81.7	108.3	85.0	80.1	72.3	70.4	65.4	80.8	78.5	83.0	83.5	77.4	70.4	65.3
17	72.9	73.4	70.5	71.2	73.5	71.2	65.2	91.3	114.3	89.8	84.9	75 5	71.5	65.5	87.6	83.1	86.9	87.2	80.3	71.5	65.5
18	76.2	79.3	74.0	74.5	76.1	72.7	65.5	93.5	120.6	92.3	87.4	78.0	72.9	65.9	89.8	87.3	89.7	89.6	82.6	73.0	65.9
19	79.3	81.9	76.6	77.0	78.2	74.3	65.9	95.2	122.8	94.0	89.5	80.0	74.5	66.3	91.1	86.5	91.3	91.5	84.8	74.5	66.3
20	79.0	83.1	77.4	78.1	79.9	75.6	66.4	96.5	128.5	95.7	91.2	81.5	75.9	66.8	93.0	91.3	93.2	93.2	86.1	75.8	66.9
21	73.5	79.1	76.1	77.2	79.9	76.7	66.9	90.2	119.4	92.0	87.9	81.0	76.6	67.2	84.8	85.4	88.8	89.2	84.8	76.5	67.2
22	72.0	81.3	77.2	78.5	80.6	77.0	67.4	85.0	96.4	85.9	82.8	80.0	77.0	67.5	74.3	72.7	78.2	79.7	80.3	76.5	67.5
23	65.1	67.6	71.7	72.8	75.8	75.9	67.6	68.7	75.5	72.9	72.6	74.4	75.4	68.0	75.8	76.5	78.2	77.4	75.5	74.8	68.1
24	67.1	72.5	71.2	71.5	73.5	74.2	68.0	81.0	100.8	80.7	78.9	74.9	74.0	68.5	79.2	77.7	80.2	80.5	78.0	73.9	68.5
25	66.9	66.8	72.0	73.0	75.0	74.0	68.3	78.1	94.0	80.0	77.2	75.0	74.0	68.5	76.3	74.0	77.8	78.5	77.2	74.0	68.5
26	66.2	70.5	69.1	70.0	73.4	73.9	68.4	77.8	91.3	79.0	76.5	74.0	73.6	68.5	75.1	70.0	76.1	76.8	76.0	72.4	68.5
27	63.8	64.8	66.5	67.7	71.6	73.0	68.2	75.0	79.6	72.7	71.0	71.2	72.9	68.5	71.5	67.1	71.9	72.2	72.3	72.4	68.4
28	65.0	64.8	65.8	67.0	70.0	71.8	68.3	78.8	99.3	78.0	74.0	70.8	71.7	68.5	76.2	74.0	79.2	78.0	75.3	71.5	68.5
29	65.9	66.6	67.5	69.0	72.2	71.7	68.3	81.5	104.5	81.1	77.0	72.8	71.8	68.4	74.1	75.9	81.2	80.0	76.0	71.8	68.2
30	68.0	70.5	69.8	71.0	73.8	72.4	68.0	82.0	107.3	84.0	79.5	74.5	72.5	68.3	81.8	80.3	84.2	82.5	78.0	72.5	68.2
Mean	67.7	70.7	69.0	69.8	72.4	71.5	65.5	82.1	99.3	82.0	78.3	73.3	71.4	6.58	78.0	75.6	79.7	79.9	76.4	71.3	65.8

*Cold spell after 1 P. M., 10th to 13th; injured and retarded the cotton crop.

TEMPERATURE OF THE AIR AND SOIL—JULY.

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	69.5	72.5	72.2	73.4	75.6	73.3	68.1	82.1	103.1	85.3	80.9	76.1	73.5	68.4	80.2	79.3	83.2	82.0	78.6	73.5	68.3
2	68.8	72.5	72.7	73.8	76.0	74.0	68.2	84.7	109.1	85.4	80.5	76.2	74.0	68.5	79.2	81.8	85.2	83.7	79.2	74.0	68.5
3	68.7	71.5	73.8	75.0	77.0	74.5	68.4	82.8	103.0	83.6	79.5	76.8	74.0	68.5	75.0	78.3	82.0	81.4	78.9	74.5	68.5
4	71.1	72.0	73.3	74.3	76.2	74.7	68.5	71.8	76.5	74.3	74.4	75.3	74.7	68.5	71.4	72.5	75.2	75.5	75.2	74.4	68.6
5	70.0	72.5	71.3	71.7	73.6	73.8	68.6	81.6	97.6	79.7	76.2	73.8	73.6	68.7	75.8	74.3	78.0	77.7	75.8	73.5	68.8
6	73.1	77.3	73.5	73.2	74.3	73.8	68.7	81.6	94.1	81.0	78.0	74.6	73.5	69.0	78.9	76.3	80.5	79.0	76.6	73.5	69.0
7	74.3	74.5	74.4	74.7	75.0	73.8	68.8	79.9	88.1	79.4	77.4	75.4	73.8	69.0	79.8	77.5	81.0	80.0	77.2	73.9	69.0
8	73.2	74.6	74.2	74.5	75.5	73.0	68.9	83.4	100.3	83.0	80.2	76.2	74.1	69.0	80.2	80.8	83.5	82.5	79.0	74.2	69.1
9	74.0	77.3	74.7	75.0	76.5	75.0	69.1	82.5	93.8	82.2	79.7	77.0	75.0	69.3	83.0	77.5	81.4	80.8	78.8	74.8	69.3
10	76.2	78.5	75.9	75.0	76.4	75.2	69.4	87.0	98.3	84.4	81.0	77.2	75.3	69.5	86.9	80.5	83.1	82.0	79.4	75.1	69.5
11	70.6	73.4	71.8	73.0	76.0	75.5	69.5	81.6	99.3	82.8	79.5	76.3	75.5	69.6	82.0	78.3	81.2	80.5	78.3	75.0	69.5
12	72.2	75.5	72.7	73.1	75.5	75.2	69.5	88.1	108.5	88.5	83.1	76.8	75.3	70.0	84.8	81.3	85.7	83.7	80.0	75.2	70.0
13	71.8	73.5	74.8	75.7	77.8	75.8	69.7	91.7	116.3	89.0	84.1	78.1	76.0	70.0	87.0	82.5	88.2	86.1	81.5	76.0	70.0
14	73.9	76.7	71.8	77.8	79.5	76.6	70.0	94.5	118.3	91.0	86.7	80.0	77.0	70.4	90.5	86.3	90.5	88.5	83.1	77.0	70.4
15	77.2	80.1	79.1	80.0	81.5	78.0	70.3	95.4	116.1	92.6	88.2	81.5	78.0	70.5	87.6	87.8	91.7	90.0	84.5	78.0	70.5
16	76.9	81.3	79.7	80.7	82.5	79.0	70.5	96.0	121.1	94.0	89.6	82.6	79.0	71.0	91.1	90.1	93.0	91.2	85.7	79.0	71.0
17	83.7	85.1	82.3	83.0	84.0	79.8	71.0	97.8	124.1	95.7	91.2	84.1	80.0	71.4	94.0	90.1	94.1	92.2	87.0	80.0	71.4
18	84.2	86.3	83.2	84.0	84.9	80.8	71.5	99.9	129.1	98.2	93.2	85.4	81.0	71.8	96.0	91.3	96.8	95.7	88.5	81.0	71.8
19	81.9	85.3	84.2	85.3	86.4	81.8	71.9	94.8	126.5	96.7	92.1	86.0	81.9	72.2	78.0	78.7	90.9	92.5	88.5	81.6	72.0
20	72.6	75.5	77.5	79.0	82.7	81.7	72.0	86.3	97.3	89.0	85.7	82.3	81.5	72.7	85.0	81.1	87.4	87.6	84.6	81.0	72.5
21	74.7	72.5	78.1	79.2	81.7	80.8	72.5	86.7	102.7	88.5	85.0	81.5	80.5	73.0	79.3	79.1	86.8	87.2	84.0	80.2	72.9
22	74.3	77.3	77.3	78.4	80.9	80.2	72.8	90.6	110.3	93.7	88.5	81.6	80.2	73.2	74.1	76.5	83.3	85.0	84.4	79.7	73.0
23	73.1	77.5	76.8	77.8	80.1	80.0	73.0	77.5	78.9	86.7	85.2	80.6	79.5	73.0	70.8	72.5	77.7	79.0	80.8	79.4	73.0
24	72.2	75.7	74.1	75.0	77.5	78.6	73.0	85.0	101.9	87.3	83.3	78.4	78.5	73.2	76.0	76.7	83.6	84.5	81.6	78.2	73.2
25	73.0	77.2	75.4	76.4	78.9	78.5	73.0	85.0	104.3	88.9	85.5	79.8	78.5	73.3	85.5	81.5	86.9	87.4	83.0	78.4	73.3
26	75.0	77.5	76.9	78.0	80.4	79.0	73.1	88.0	113.3	91.1	86.2	80.6	79.0	73.4	83.7	83.7	88.6	88.5	83.8	78.9	73.4
27	75.0	78.3	77.0	78.1	80.6	79.2	73.1	89.1	114.5	92.0	87.1	81.0	79.3	73.4	78.9	81.1	87.8	88.5	84.3	79.1	73.2
28	74.0	76.7	77.6	78.6	80.8	79.5	73.1	85.0	91.3	87.6	85.1	81.0	79.5	73.4	77.8	78.3	84.2	85.0	83.0	79.3	73.4
29	73.8	77.5	76.1	77.1	79.8	79.2	73.3	87.4	107.3	90.5	85.8	80.5	79.3	73.5	78.4	79.1	83.9	84.8	83.0	78.8	73.3
30	72.9	75.5	76.3	77.3	79.6	79.0	73.5	85.9	92.5	86.2	83.7	80.0	79.0	73.5	77.3	78.4	81.3	81.8	81.0	78.7	73.4
31	74.6	75.9	77.0	77.6	78.9	78.7	73.4	80.8	88.4	86.6	83.8	79.5	78.5	73.5	77.0	77.8	81.1	81.6	80.5	78.4	73.5
Mean	74.2	76.7	76.0	77.0	78.9	77.4	70.9	86.6	104.1	87.6	83.9	79.2	77.4	71.1	81.5	80.4	85.1	84.7	81.6	77.2	71.1

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	76.0	77.5	77.0	77.5	78.6	78.4	73.5	86.7	97.8	88.3	84.8	79.6	78.4	73.5	...	...	...	...	...	...	...
2	76.0	77.9	76.6	77.4	79.2	78.5	73.5	82.2	85.3	83.3	81.5	79.0	78.4	73.5	74.8	75.7	79.8	80.6	80.4	*78.2	73.4
3	74.6	76.7	76.7	77.2	78.2	78.0	73.4	79.1	83.5	79.7	78.9	78.0	77.9	73.5	79.6	78.3	80.8	80.9	79.1	77.1	73.4
4	74.2	75.3	76.2	76.8	78.0	77.5	73.4	76.1	82.3	81 6	80.3	78.0	77.5	73.5	75.7	76.3	80.4	81.3	79.6	77.5	73.5
5	73.0	74.5	75.6	76.3	77.7	77.5	73.4	83.4	91.3	85.0	82.3	78.2	77.5	73.5	82.0	79.8	82.0	84.4	81.3	77.5	73.5
6	76.3	78.3	76.9	77.6	79.0	78.0	73.4	87.3	98.3	87.6	84.4	79.7	78.0	73.5	73.3	76.5	83.4	84.8	82.2	78.0	73.3
7	70.8	72.5	76.0	77.0	79.0	78.2	73.3	77.6	95.2	83.3	80.5	78.4	78.1	73.3	75.0	75.9	81.2	82.2	80.5	77.9	73.4
8	67.8	69.7	73.4	74.8	77.5	77.9	73.3	73.7	76.5	77.0	76.6	76.7	77.5	73.3	72.0	73.0	76.9	77.5	77.3	77.0	73.3
9	64.0	68.1	68.4	70.1	74.4	76.5	73.2	76.0	95.5	83.7	79.5	74.9	76.3	73.4	73.6	71.8	79.1	80.5	78.3	76.0	73.2
10	64.2	68.5	69.0	70.5	74.6	76.0	73.0	80.8	97.3	84.6	80.5	75.3	76.0	73.3	79.9	76.5	81.9	82.5	79.0	75.7	73.1
11	68.2	71.6	71.8	73.1	76.1	76.0	73.0	87.4	101.3	88.0	83.0	76.7	76.1	73.2	81.4	79.5	85.2	85.5	80.6	76.1	73.0
12	74.8	74.5	74.5	75.7	78.0	76.7	72.9	89.1	110.3	91.9	86.0	78.5	76.9	73.1	84.2	81.3	87.1	87.6	82.5	76.8	73.0
13	75.0	77.3	77.4	78.4	80.0	77.5	73.0	82.6	97.3	88.8	85.7	80.2	77.7	73.0	76.2	78.3	85.0	86.0	82.5	77.7	73.0
14	73.0	75.9	77.2	78.2	79.6	78.0	73.0	81.0	99.3	83.1	80.9	79.1	78.0	73.0	79.3	79.3	85.6	86.3	82.0	77.9	73.0
15	70.5	73.0	74.7	75.9	78.5	78.0	73.0	83.2	90.8	84.7	81.9	78.5	78.0	73.2	82.4	80.4	82.9	83.2	80.7	77.6	73.1
16	70.3	74.7	74.1	75.5	78.2	77.7	73.0	85.0	100.3	87.8	84.5	79.0	77.8	73.3	81.1	77.0	83.0	84.1	81.6	77.6	73.2
17	72.5	73.6	75.2	76.0	78.2	77.8	73.1	84.8	100.3	87.5	83.8	78.9	77.8	73.5	82.0	78.8	84.0	85.0	81.5	77.6	73.3
18	72.2	76.5	74.0	76.2	78.0	77.8	73.2	84.5	94.5	86.1	83.4	78.6	77.7	73.5	78.0	78.2	82.1	83.0	81.0	77.5	73.3
19	72.2	77.3	76.1	76.9	78.5	77.6	73.3	82.4	95.8	86.8	83.1	78.6	77.7	73.5	78.3	78.3	82.9	83.6	81.1	77.5	73.4
20	73.9	75.5	75.6	76.6	78.4	77.6	73.4	84.0	102.5	88.2	84.6	79.0	77.7	73.5	80.1	78.9	84.8	85.7	82.5	77.6	73.5
21	73.0	75.5	74.9	76.1	79.0	78.0	73.4	86.1	103.5	89.6	85.6	79.5	78.2	73.5	79.2	77.7	85.4	86.7	83.0	78.0	73.5
22	74.2	77.3	76.7	77.7	79.5	78.4	73.4	85.1	107.1	90.8	86.5	80.2	78.5	73.6	80.4	78.8	85.4	86.7	83.5	78.3	73.5
23	75.0	77.3	77.0	78.0	80.0	78.6	73.5	85.8	108.3	91.2	87.3	80.7	78.7	73.8	74.0	77.5	85.2	87.3	84.0	78.5	73.6
24	70.0	72.3	75.1	76.6	79.5	78.8	73.5	*82.0	94.1	84.4	81.6	78.8	78.6	73.7	78.7	77.3	83.2	84.4	81.8	78.4	73.6
25	67.8	66.8	72.3	74.7	78.4	48.4	73.5	75.8	105.1	88.2	83.7	78.4	78.5	73.8	70.1	71.5	83.0	84.6	81.8	77.9	73.7
26	59.8	63.0	68.1	70.8	76.5	77.9	73.5	73.8	94.3	82.0	79.0	76.2	77.7	73.8	69.3	73.5	81.1	82.2	79.1	77.0	73.7
27	64.0	64.8	69.5	72.0	76.4	77.0	73.5	64.0	68.3	70.2	71.0	74.0	76.5	73.5	62.0	64.8	70.0	71.1	73.5	76.0	73.5
28	60.9	64.5	66.4	67.6	71.2	74.9	73.4	70.1	90.6	75.0	72.2	71.2	74.5	73.5	69.9	67.8	74.0	75.0	74.0	74.0	73.4
29	60.5	62.8	66.3	67.6	71.3	73.9	73.1	72.2	90.3	79.0	75.4	71.6	73.7	73.2	65.3	65.3	73.6	75.0	74.5	73.4	73.0
30	55.8	57.3	62.2	64.4	70.0	73.4	72.6	72.7	89.7	76.9	73.5	70.2	73.0	72.8	66.0	63.8	72.0	73.5	73.0	72.5	72.6
31	56.7	57.7	61.8	63.9	69.0	72.5	72.4	73.8	87.8	77.6	73.8	69.6	72.3	72.5	66.6	64.8	73.7	74.8	73.0	71.9	72.4
Mean.....	69.6	71.9	73.1	74.4	77.4	77.2	73.2	80.3	94.9	84.2	81.2	77.3	77.1	73.4	75.7	75.2	81.1	82.2	80.1	76.8	73.3

*Cotton just beginning to open on manured lands.

TEMPERATURE OF THE AIR AND SOIL—SEPTEMBER.

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	56.1	57.7	61.9	64.0	69.0	71.9	72.0	73.0	96.0	79.0	74.3	69.6	71.8	72.2	67.3	65.0	75.0	76.2	73.6	71.5	72.1
2	57.8	58.1	62.3	64.4	69.6	71.7	71.5	76.0	101.0	81.2	76.2	70.4	71.7	71.9	71.6	68.7	77.7	78.6	74.7	71.5	71.6
3	60.4	60.8	64.6	66.4	70.8	72.0	71.3	80.3	102.3	81.6	77.6	71.5	72.3	71.8	76.3	72.5	79.7	80.6	76.0	72.0	71.5
4	65.7	66.8	69.0	70.1	72.9	72.6	71.2	76.4	100.3	81.3	77.9	73.2	72.8	71.4	69.6	69.5	78.1	79.3	76.5	72.7	71.4
5	57.6	60.8	64.6	66.9	72.0	73.0	71.0	71.4	88.1	76.3	74.6	72.0	72.9	71.0	68.8	65.8	75.0	76.4	73.9	74.0	72.0
6	58.9	59.3	63.3	65.2	70.5	72.5	70.9	77.6	107.3	84.7	79.1	71.5	72.5	71.3	73.1	70.5	79.8	80.8	76.3	72.2	71.1
7	65.4	64.9	67.2	69.0	72.5	72.6	70.9	82.1	104.3	82.8	79.0	73.1	72.9	71.2	76.0	74.5	80.0	80.8	76.7	72.7	71.0
8	70.0	70.3	71.3	72.4	74.5	73.4	71.0	80.0	108.3	87.6	82.7	75.4	73.5	71.3	70.2	70.3	81.5	82.9	79.2	73.5	70.9
9	58.3	59.8	66.8	69.2	74.2	74.1	70.7	†76.7	110.1	86.1	81.0	74.5	74.3	71.3	75.0	70.5	81.0	82.3	78.4	73.9	71.2
10	63.2	67.2	68.2	70.0	74.3	74.3	70.9	83.9	113.6	88.0	82.6	74.9	74.5	71.3	78.8	76.5	84.7	85.0	78.8	74.0	71.0
11	66.0	69.7	71.6	73.2	76.0	74.9	71.0	84.8	114.3	87.7	83.3	76.6	75.2	71.4	79.0	77.5	85.3	85.9	80.5	75.0	71.3
12	66.0	69.0	71.7	73.6	76.9	75.6	71.2	82.7	104.5	89.4	84.4	77.4	75.8	71.5	76.8	76.9	85.5	86.0	81.1	75.6	71.5
13	70.8	74.5	73.0	74.6	77.5	76.2	71.4	87.9	118.3	91.2	85.9	78.3	76.4	71.8	83.1	81.0	88.0	88.2	82.4	76.3	71.6
14	73.4	74.7	76.2	77.4	79.4	77.0	71.6	93.2	123.9	95.0	89.1	80.2	77.3	72.1	79.3	80.2	85.6	86.5	83.6	77.1	71.9
15	70.0	71.8	74.8	76.1	78.8	77.6	71.8	84.5	99.8	86.6	83.0	78.6	77.7	72.3	78.3	77.5	82.9	83.7	81.4	77.3	72.2
16	67.8	69.5	73.7	75.3	78.1	77.4	72.1	†72.7	91.3	81.2	79.0	77.3	77.4	72.4	68.3	66.8	77.4	78.9	78.8	76.9	72.3
17	55.0	57.5	64.7	67.2	74.5	76.3	72.0	69.0	86.3	77.6	75.1	73.0	75.7	72.5	62.2	64.8	73.7	75.3	75.0	75.0	72.3
18	58.6	61.0	65.6	67.3	74.7	74.6	72.3	70.1	86.1	72.7	71.0	71.2	74.3	72.4	66.9	67.7	72.8	73.4	72.9	73.6	72.3
19	63.7	64.8	67.8	68.7	71.4	73.4	72.2	72.8	87.3	75.8	72.8	71.2	73.2	72.2	68.2	67.9	76.0	76.9	74.4	73.0	72.1
20	59.1	59.6	64.6	66.6	71.2	73.0	71.9	79.0	106.5	84.4	79.0	72.0	73.2	72.0	73.9	70.0	80.0	80.8	77.5	72.9	72.0
21	61.0	60.5	65.9	68.0	72.6	73.5	71.6	79.6	108.1	85.2	80.1	73.4	73.6	72.0	72.8	70.5	80.3	81.2	77.4	73.4	71.8
22	66.8	66.8	69.7	70.9	73.6	74.0	71.5	83.9	109.5	84.0	78.9	73.9	74.0	71.8	73.6	71.5	80.7	81.3	77.4	73.8	71.6
23	66.9	66.8	71.0	72.2	74.6	74.4	71.5	57.8	61.8	71.2	72.5	73.5	74.1	71.5	54.8	56.7	65.5	67.7	71.9	73.7	71.4
24	47.2	45.9	56.3	59.7	67.1	72.4	71.2	56.1	74.5	66.8	65.1	66.0	71.7	71.5	49.1	49.1	61.8	64.2	67.4	70.7	71.3
25	*39.9	41.7	51.0	54.0	62.4	69.7	71.0	59.2	81.6	67.0	63.7	62.3	69.0	71.3	54.8	55.8	64.7	65.8	65.5	68.3	71.1
26	41.1	43.9	52.7	55.3	62.2	68.0	70.5	63.1	90.3	73.0	66.0	62.5	67.8	70.9	58.8	56.1	67.2	68.4	66.6	67.4	70.6
27	51.1	52.8	57.3	59.2	63.8	67.5	70.2	65.6	74.2	68.2	65.9	64.1	67.5	70.2	59.1	59.0	63.8	64.7	65.5	67.2	70.1
28	62.3	61.5	62.2	62.6	64.4	67.2	69.8	§72.9	76.8	67.7	66.0	65.0	67.2	69.8	73.2	69.0	69.9	69.2	67.1	67.3	69.7
29	72.8	71.7	69.4	68.8	67.9	67.6	69.5	82.6	92.5	79.0	74.9	69.5	68.1	69.5	73.9	73.8	76.0	75.7	72.3	68.4	69.5
30	70.0	70.3	71.0	71.2	71.4	69.5	69.2	79.3	86.3	81.3	78.3	72.4	69.9	69.4	73.9	72.7	75.8	76.0	73.9	70.1	69.4
Mean	61.4	62.6	66.3	67.9	71.8	72.9	71.1	75.8	97.2	80.4	76.6	72.1	72.9	71.4	70.2	68.9	76.8	77.8	75.2	72.7	71.3

*Equinoxial storm. †Slight frost first of the season. ‡First picking of cotton on manured, well drained loam. ‖First picking of cotton on manured red clay; second picking on the loam. Cotton opened rapidly on 13th and 14th. For date of other pickings, see body of report. §Cotton just opening in unmanured loam around soil thermometers. Much later than on the adjacent manured land, but earlier than on the unmanured clay.

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	61.5	61.8	66.6	68.0	71.1	70.7	69.0	76.2	91.3	79.0	75.4	70.9	70.8	69.4	70.0	64.1	72.9	74.2	73.4	70.6	69.2
2	56.8	56.2	62.0	63.8	68.6	70.7	69.0	79.5	95.5	78.8	74.7	69.2	70.5	69.2	70.3	66.4	74.3	75.2	72.8	70.3	69.4
3	63.4	59.8	64.1	65.6	60.4	70.5	69.3	81.8	99.5	80.2	76.0	70.1	70.6	69.5	71.8	71.0	77.0	77.2	73.9	70.4	69.4
4	53.0	51.7	62.1	64.7	69.7	70.7	69.2	74.1	94.7	77.3	74.0	69.5	70.8	69.5	64.9	61.0	72.3	73.9	72.4	70.4	69.4
5	49.0	47.0	57.7	60.7	67.2	70.4	69.0	*61.9	84.5	71.6	69.0	66.6	70.0	69.4	56.2	55.9	67.9	69.2	69.2	69.4	69.2
6	45.1	44.9	55.0	57.9	64.5	69.0	68.9	66.8	98.1	74.0	69.2	64.8	68.6	69.4	60.2	55.9	69.2	70.4	68.6	68.1	69.1
7	48.9	48.8	56.7	59.1	64.7	68.2	68.8	75.1	100.9	75.5	70.7	65.4	68.1	69.1	65.8	60.0	71.9	72.7	69.5	67.8	69.0
8	56.6	55.5	60.0	61.9	66.1	68.1	68.6	78.7	106.1	78.0	74.0	67.4	68.4	69.0	69.9	64.0	74.6	75.2	71.5	68.1	68.8
9	61.8	60.1	63.7	65.0	68.4	69.0	68.5	82.0	106.7	80.6	75.7	69.0	69.0	68.9	74.2	67.8	76.6	77.1	73.4	69.0	68.6
10	62.0	62.1	65.0	66.7	68.9	68.9	68.5	84.0	109.1	82.4	77.3	70.6	70.0	68.9	75.2	69.6	78.3	78.9	74.8	69.9	68.7
11	64.3	64.8	67.1	68.6	71.4	70.8	68.5	75.6	83.9	79.7	77.0	71.7	70.8	68.8	55.0	67.8	70.1	72.2	73.0	70.6	68.6
12	44.8	47.4	56.6	59.8	66.8	70.3	68.4	57.8	76.1	66.7	65.0	65.6	69.8	68.6	52.0	49.9	63.6	65.6	67.2	69.0	68.5
13	39.0	42.3	51.9	54.9	62.2	68.1	68.5	66.4	92.6	71.1	66.3	62.5	67.7	68.8	59.7	54.9	67.1	68.2	66.6	67.0	68.5
14	45.9	45.1	54.3	57.0	63.0	67.0	68.4	65.0	87.6	71.2	67.0	63.0	67.0	68.4	55.0	51.9	66.0	67.5	66.5	66.5	68.4
15	42.3	41.4	52.1	55.1	62.0	66.5	68.0	57.0	81.1	66.6	63.3	61.5	66.2	68.1	47.1	46.2	61.7	63.4	64.1	65.6	67.9
16	42.2	45.0	51.6	63.4	59.6	65.4	67.6	64.2	86.3	67.8	63.5	60.0	65.0	67.8	59.1	58.1	65.9	66.3	64.1	64.5	67.5
17	52.0	51.9	57.2	58.3	61.9	64.9	67.5	73.4	87.4	73.1	68.2	62.7	65.0	67.6	69.0	65.5	70.2	70.2	66.7	64.9	67.5
18	60.0	61.8	63.3	63.9	65.5	65.7	67.1	62.0	64.8	64.4	64.1	64.9	65.8	67.1	61.8	62.0	64.0	64.3	65.0	65.8	67.1
19	59.5	60.4	62.1	62.6	64.1	65.8	67.0	62.9	68.7	64.8	64.0	64.0	65.7	67.0	61.1	61.5	64.3	64.6	64.7	65.5	66.8
20	58.8	58.8	61.5	62.0	63.7	65.5	66.7	61.8	62.6	62.2	62.2	63.5	65.5	66.6	57.1	58.3	61.7	62.3	63.4	65.2	66.6
21	54.4	53.2	57.9	58.8	61.5	65.0	66.5	61.7	72.6	65.8	64.0	62.0	64.7	66.6	51.7	45.5	57.3	59.8	62.8	64.4	66.5
22	37.7	36.2	47.3	49.9	57.0	63.7	66.1	56.1	68.6	60.1	57.6	56.6	63.1	66.4	50.1	45.3	56.2	57.9	59.0	62.4	66.1
23	38.1	38.0	47.7	49.5	55.5	62.0	66.0	65.0	72.7	61.9	59.0	56.1	61.6	66.0	59.0	54.2	58.0	58.4	58.5	61.1	65.8
24	57.1	53.9	55.2	55.9	58.0	61.1	65.6	71.0	72.5	64.5	62.0	59.0	61.4	65.6	62.7	61.6	62.5	62.3	61.0	61.3	65.5
25	49.3	45.9	55.0	56.9	60.0	61.6	65.0	43.5	45.0	53.0	54.5	58.0	61.8	65.0	42.9	45.0	50.7	52.1	56.5	61.4	64.8
26	42.7	45.0	48.3	49.3	53.7	60.3	64.5	45.6	49.2	49.6	49.9	53.4	59.5	64.5	45.0	49.1	50.0	51.0	51.5	59.0	59.5
27	45.8	49.3	50.2	51.0	64.2	58.4	64.1	50.1	54.9	53.1	52.8	54.0	58.2	64.0	49.0	54.7	52.8	53.1	54.5	58.2	64.0
28	49.3	54.9	52.1	52.6	54.6	58.0	63.5	53.6	58.1	55.1	54.6	55.0	58.0	63.5	52.8	58.1	55.2	55.4	55.9	57.9	63.4
29	51.3	58.1	54.2	54.4	55.9	58.0	63.0	54.5	59.9	56.7	56.0	56.0	57.1	63.0	54.8	57.9	56.8	56.9	56.9	58.0	62.8
30	50.9	57.9	54.4	55.0	56.5	58.4	62.6	49.4	57.9	55.0	55.3	56.2	58.4	62.6	45.0	48.2	51.9	53.0	55.6	58.2	62.5
31	34.2	35.0	44.0	46.0	52.0	57.8	62.2	34.1	35.2	43.3	45.0	49.8	57.0	62.0	34.0	32.0	41.0	43.2	49.8	58.5	62.0
Mean	50.2	51.4	56.7	58.3	62.5	65.5	67.0	64.2	78.2	77.0	68.0	62.6	65.4	67.2	58.1	56.9	64.0	64.9	64.7	65.1	66.8

*First picking of cotton on unmanured loam around soil thermometers.

TEMPERATURE OF THE AIR AND SOIL—NOVEMBER.

DATE.	7 A. M.							1 P. M.							7 P. M.						
	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in	Air.	Sur.	3 in.	6 in.	12 in	24 in	48 in
1	41.0	41.0	45.1	46.2	48.7	55.0	61.9	54.4	63.8	53.0	50.8	49.4	54.5	61.8	47.9	44.2	51.6	52.1	51.8	54.4	61.6
2	33.8	35.1	41.8	43.8	49.0	54.5	61.3	56.0	70.7	54.6	51.2	49.0	54.4	61.3	50.3	45.0	52.9	53.4	52.5	54.0	61.0
3	39.0	36.0	43.7	45.0	49.9	54.4	60.6	67.0	78.5	58.6	54.7	50.3	54.4	60.8	55.9	49.7	56.0	56.6	54.4	54.3	60.5
4	43.0	42.5	47.1	48.1	52.0	55.0	60.1	68.1	74.1	58.1	55.3	52.4	55.0	60.1	61.7	53.7	55.6	56.1	55.0	54.9	60.0
5	40.0	38.0	47.3	48.8	52.8	55.5	59.9	51.7	68.0	55.3	53.0	52.0	55.5	59.9	47.0	43.3	53.0	54.0	54.2	55.4	59.8
6	32.0	34.0	42.7	44.6	50.4	55.3	59.5	56.7	67.7	55.6	52.3	50.0	55.0	59.7	50.5	43.2	52.3	53.2	53.0	54.6	59.5
7	38.3	36.0	43.4	45.0	50.0	54.7	59.4	58.1	64.0	52.3	50.7	49.9	54.5	59.4	52.8	49.7	52.4	52.5	52.0	54.2	59.4
8	55.8	53.9	52.0	52.0	52.4	54.4	59.2	60.9	64.6	57.7	55.9	53.3	54.6	59.2	59.0	53.9	58.0	58.2	55.9	54.7	59.0
9	45.7	45.0	50.9	51.8	54.1	55.5	58.9	54.0	58.7	54.2	53.1	53.4	55.5	58.9	48.3	46.0	52.6	53.3	54.1	55.5	58.8
10	47.0	48.0	49.8	50.0	52.2	55.5	58.7	49.8	51.6	52.6	52.1	52.5	55.3	58.8	48.1	46.2	51.4	51.9	52.8	55.6	58.7
11	42.0	36.2	42.2	44.0	49.5	54.7	58.5	50.1	59.9	51.2	49.6	49.0	54.5	58.6	47.9	40 8	48.3	49.4	50.8	54 0	58.5
12	36.0	36 8	39.7	41.6	47.4	53.5	58.3	51.0	63.6	51.5	48.8	47.4	52.4	58.4	44.0	39.0	47.4	48.3	49.5	52.7	58.3
13	32.6	31.0	38.6	40.4	46.0	52.5	57.9	50.0	67.8	52.9	49.2	46.5	52.4	58.1	45.9	42 0	49.0	49.4	49.5	51.8	58.0
14	38.0	38.1	42.0	43.2	47.3	52.0	57.5	57.9	67.3	51.2	48.5	47.1	52.0	57.6	51.1	50.0	50.8	50.6	49.6	51.7	57.5
15	46.6	45.3	49.0	49.0	50.0	52.0	57.4	54.0	61.0	54.6	52.5	50.5	52.4	57.4	47.9	41.0	49.2	50.2	51.4	52.4	57.1
16	39.7	35 5	41.2	42.8	47.5	52.5	56.9	59.7	71.4	54.4	51.0	48.0	52.4	57.1	51.7	44.8	51.0	51.7	51.0	52.0	57.0
17	51.1	45.0	46.7	46.8	49.4	52.4	56.9	66.5	67.9	57.0	53.7	50.0	52.5	57 0	56.6	51.1	53.7	53.8	52.3	52.5	56.8
18	40.0	36.5	43.6	45.1	49.6	52.8	56.5	47.1	49.3	47.2	46.7	48.4	52.7	56.4	44.1	43.0	46.1	46.3	48.5	52.3	56.5
19	39.0	41.0	44.3	45.0	47.5	51.8	56.5	42.3	49.4	46.7	46.5	47.5	51.8	56.4	43.1	41.0	46.1	46 5	48.0	51.5	56.2
20	34.6	31.0	41.3	43.2	47.0	51.2	56.1	38.9	48.9	47.8	45.8	46.0	51.0	56.1	32.2	29.5	41.7	43 8	47.0	50.6	56.0
21	24.9	24.0	35.8	37.7	43.0	50.0	55.8	37.7	47.0	41.3	39.1	41.8	49.6	55.8	33.7	29.5	39.6	41 0	43.4	48.9	55.6
22	27.6	27.0	35.7	37.3	41.5	48.4	55.5	53.7	59.6	46.3	42.7	41.5	48.2	55.5	44.1	37.0	43.2	44.2	44.5	47.7	55.4
23	35.8	32.0	36.8	38.3	42.4	47.9	55.0	59.5	65.7	48.5	45.3	43.0	48.0	55.0	53.1	53.7	47.5	45.1	46.7	47.7	55.0
24	42.4	34.5	42.3	43.2	45.5	48.2	54.6	65.9	73.3	55.6	51.7	46.5	48.6	54.8	55.5	49.0	51.8	51.8	49.7	48.8	54.5
25	41.8	39.8	43.9	45.0	47.8	49.5	54.2	68.1	78.3	58.0	53.7	48.5	50.0	54.5	62.0	53.5	55.0	55.0	52.0	50.0	54.4
26	55.2	52.9	52.0	51.9	51.5	51.0	54.4	70.7	77.5	60.6	57.0	52.4	51.5	54.5	64.8	59.8	58.0	57.8	54.8	51.8	54.4
27	51.7	48.0	50.2	51.1	53.0	52.7	54.3	74.7	84.3	63.8	60.0	53.8	53.0	54.5	64.0	58.1	59.8	59.8	56.5	53.2	54.5
28	61.4	60.0	57.0	56.6	55.6	54.1	54.5	55.1	57.9	57.1	57.0	56.0	54.5	54.4	45.2	45.2	51.8	52.9	55.0	54.5	54.5
29	26.5	25.0	39.6	42.2	49.5	54.0	54.5	....	....	....	....	....	....	....	35.9	32.0	41.8	43.8	46.5	52.4	54.4
30	26.6	24.8	36.5	38.0	43.8	51.1	54.7	41.5	52.7	43.0	41.2	43.0	50.5	54.8	34.2	31.0	39.8	41.2	44.4	49.8	54.8
Mean	40.3	38.4	44.1	45.2	48.9	52.1	57.3	55.9	64.4	53.1	50.7	49.0	52.6	57.3	49.3	44.8	50.2	50.8	50.9	52.4	57.2

DATE.	MAY.		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	78.0	47.4	82.1	61.0	85.0	64.5	82.2	73.5	75.0	52.8	78.3	61.0	56.2	33.1
2	86.3	52.5	79.2	59.7	88.8	65.5	84.4	73.3	79.0	53.3	81.9	57.0	59.5	‡33.0
3	88.2	58.0	83.1	64.0	85.0	65.4	80.8	73.9	84.0	57.5	84.0	61.4	69.2	*38.4
4	88.8	-- --	83.9	65.1	73.0	68.0	81.7	73.4	77.9	63.6	76.0	52.4	70.1	43.0
5	84.0	61.8	85.9	63.0	82.9	67.8	87.0	72.2	74.2	53.2	64.2	47.3	55.1	40.0
6	78.9	63.5	84.8	65.8	83.9	71.8	89.6	73.3	80.2	54.9	69.8	43.0	59.2	*31.0
7	81.6	62.3	89.0	66.2	84.5	72.5	80.0	69.7	84.1	62.2	77.7	47.0	60.0	36.4
8	80.3	66.3	85.9	69.1	87.2	71.2	75.8	66.7	80.9	68.7	81.1	55.6	67.0	52.0
9	77.6	61.3	89.0	67.8	86.6	70.0	78.4	60.1	80.0	55.7	84.3	60.0	55.0	44.6
10	72.5	61.1	86.2	70.1	90.0	73.5	84.0	60.6	86.8	61.1	86.0	61.0	51.2	44.5
11	77.1	63.6	72.9	58.2	85.0	68.0	89.8	65.8	86.2	65.1	82.7	55.0	58.1	36.2
12	81.0	60.0	74.3	49.8	91.8	67.0	91.5	71.0	85.8	62.4	61.7	44.2	52.2	35.6
13	81.9	63.8	83.1	52.5	94.8	68.0	85.0	73.2	90.7	67.1	70.0	*37.2	52.1	§31.0
14	71.8	57.0	88.3	52.5	97.0	70.9	85.5	72.0	94.5	71.7	67.0	45.2	57.9	37.6
15	74.5	42.8	82.2	58.8	98.0	72.0	87.0	68.0	86.8	69.2	59.5	41.0	55.0	46.2
16	80.8	48.6	85.8	55.0	98.0	72.0	87.0	67.7	78.3	66.7	66.5	35.2	62.7	38.5
17	85.0	56.6	94.5	65.9	100.0	79.2	86.0	69.0	69.5	53.8	76.0	47.8	68.0	50.5
18	88.6	59.4	96.0	72.7	101.5	79.0	87.1	68.2	71.8	56.8	69.9	59.2	47.5	38.2
19	87.8	66.8	97.0	72.0	97.0	78.0	85.7	68.4	76.4	62 5	63.5	59.1	45.0	38.8
20	83.6	60.8	99.8	70.9	89.0	70.2	86.9	72.6	80.0	55.8	65.0	57.0	40.7	32.0
21	83.2	62.8	93.8	71.0	89.0	73.0	87.2	69.1	81.7	57.5	62.0	51.4	41.8	24.2
22	77.8	57.0	87.0	69.1	93.8	72.0	87.0	72.7	85.0	62.2	59.3	36.0	56.0	27.2
23	75.1	64.0	76.8	65.0	86.8	70.8	87.7	73.1	71.3	54.3	66.6	37.0	61.9	32.9
24	79.2	65.5	85.0	65.0	88.0	68.9	85.8	68.7	58.2	45.3	72.1	55.2	67.2	38.7
25	83.8	61.3	80.6	66.7	89.0	68.5	77.7	67.5	61.1	*37.8	46.0	42.0	69.8	41.4
26	80.8	60.1	79.8	62.4	90.2	72.2	76.0	55.2	66.1	40.0	45.6	41.0	72.0	54.0
27	75.8	58.2	75.9	60.2	89.8	72.0	65.0	62.0	65.9	49.5	50.4	44.6	74.2	49.4
28	75.0	54.1	82.5	59.9	87.2	72.5	73.6	60.0	77.9	56.6	54.0	48.6	64.0	43.6
29	77.2	54.5	84.0	56.8	90.3	70.5	73.8	59.2	84.0	70.8	55.2	51.1	43.2	26.1
30	78.2	58.8	85.8	59.5	86.2	71.1	73.2	51.9	80.8	69.4	55.0	45.0	42.0	25.5
31	69.8	63.0	.....	.....	85.0	74.0	75.7	51.7	-- --	.....	35.4	‡33.2	-- --	.....
Mean	80.1	59.1	85.1	63.2	89.5	71.0	82.5	67.2	78.5	58.6	66.7	48.8	57.8	38.1
Range	21.0		21.9		18.5		15.3		19.9		17.9		19.7	

*Frost. †Severe storm of rain, hail and snow. ‡Frost, ground frozen. §Heavy frost and ice formed.

RAINFALL*—INCHES.

DATE.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	0.25		0.72		0.30	trace.		0.34
2	trace.		0.29		1.27			
3				trace.	0.68			
4			0.13	0.90	0.24	trace.		
5				trace.	0.01			
6		0.30			0.71			trace.
7		0.22	0.03	0.25	0.02			
8		0.02	0.78	1.88	0.22		trace.	0.12
9			0.35		trace.		trace.	0.02
10		0.27	0.65		trace.			0.34
11			0.02		trace.			
12		0.27			trace.		0.10	
13		0.03						
14					1.05	0.25		0.11
15	trace.				0.03	trace.		0.02
16					0.12	0.15		
17	0.12				0.71			
18	0.31				0.13		1.26	
19				0.35	0.18		0.18	0.02
20	trace.		0.07	0.04			*1.19	
21	trace.			0.09	trace.	trace.		
22	trace.		0.29	1.01	trace.			
23		0.26	2.87	0.35	0.17	0.39		
24		0.44	0.02	0.03	0.01		0.10	
25	1.05	0.55					0.78	
26	0.01	0.45					1.68	
27	0.02				4.16		0.48	
28	0.28		trace.	0.25	0.02	0.09	0.19	0.03
29	0.06			0.69	0.77	1.44		
30		trace.		0.08		trace.	0.07	
31		0.65		0.19	trace.		4.18	
Total	2.10	3.46	6.22	6.11	10.80	2.32	10.21	1.00

*This data is taken from the Signal Service record at the Farm until 7 P. M. Oct. 19; after this the record is from the city station about 1¼ miles from the Farm.

MEAN RELATIVE HUMIDITY.

NOTE.—Data taken from Signal Service Record, at the Farm May 1, Sept. 4; in Raleigh Sept. 5—Nov. 31.

DATE.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	47.0	93.0	74 0	90.3	75.3	73.7	76.3
2	57.3	85.0	74.7	86.7	77.7	76.7	74.7
3	60.3	65.0	84.7	94.0	78.0	77.0	73.0
4	64.3	67.7	95.0	92.3	84.3	58.0	70.7
5	67.3	75.0	91.0	85.7	82.7	65.0	77.7
6	79.3	77.7	87.7	85.0	82.7	80.0	80.0
7	78.3	74.0	91.0	84.7	79.7	80.3	81.3
8	76.7	79.7	87.7	92.3	75.3	82.3	78.3
9	80.3	81.0	80.0	82.7	82.3	76.0	87.0
10	90.3	83.0	67.7	83.0	84.0	70.0	95.0
11	81.3	67.3	67.0	79.0	83.0	79.6	61.0
12	81.7	55.0	77.3	70.0	82.7	76.7	62.0
13	85.0	48.3	69.7	90.0	81.3	74.7	83.3
14	56.7	54.0	70.0	88.7	77.3	68.0	95.3
15	54.3	67.3	73.0	86.0	83.3	68.3	69.0
16	52.3	68.3	71.3	77.0	74.0	77.3	65.0
17	63.3	52.7	60.0	88.7	77.7	83.0	68.7
18	56.7	57.0	61.7	86.0	86.7	97.0	64.3
19	63.7	54.7	72.3	89.3	81.3	95.3	96.0
20	76.7	59.3	82.7	82.0	81.0	97.0	60.7
21	70.3	66.0	85.3	85.0	83.7	63.0	63.0
22	75.0	84.3	82.3	84.7	77.7	68.7	71.3
23	88.7	89.7	96.3	88.0	90.0	70.7	76.7
24	89.3	85.7	85.0	83.0	67.0	86.7	84.3
25	64.7	72.0	82.7	66.7	78.7	97.0	78.3
26	65.7	66.3	76.3	78.3	83.3	97.0	84.7
27	65.0	69.3	80.7	97.0	84.7	97.0	87.7
28	60.0	63.7	84.7	89.0	93.0	97.0	88.0
29	65.3	61.3	82.3	77.3	96.3	95.0	55.0
30	71.7	71.0	95.3	77.7	90.3	92.7	62.3
31	95.3	.....	94.7	77.7	.....	97.0	.....
Mean	70.4	68.4	80.1	84.4	81.8	81.2	75.7

DAILY WIND MOVEMENT.*

DATE.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	105	152	89	95	72	58	205
2	171	187	115	128	52	79	79
3	139	139	121	78	55	147	102
4	122	87	194	169	110	185	107
5	176	88	147	129	**48	176	118
6	196	134	145	161	57	108	76
7	152	161	109	110	127	76	48
8	136	123	97	77	152	79	48
9	99	124	148	71	91	85	96
10	111	153	159	50	73	110	99
11	64	310	84	105	78	104	188
12	79	255	36	82	85	191	186
13	77	213	39	122	115	53	57
14	189	166	56	88	61	103	36
15	70	163	63	99	79	156	190
16	127	56	60	121	121	125	71
17	80	133	109	120	129	† 75	119
18	98	135	82	119	110	138	106
19	108	116	154	65	85	95	120
20	117	111	55	103	81	163	186
21	95	146	82	76	48	191	122
22	122	216	121	71	110	95	90
23	165	134	84	90	134	85	119
24	128	50	58	140	211	127	62
25	117	155	38	190	105	213	49
26	156	141	96	75	50	204	41
27	140	161	114	147	65	161	66
28	163	118	75	77	85	129	236
29	73	91	62	66	209	41	286
30	142	85	72	89	78	94	271
31	136	.....	76	99	.....	371	.....
Total....	3853	4303	2940	3212	2876	4017	3582
Mean	124	143	95	104	96	130	119

*NOTE.—This data is taken from the Signal Service record at the Farm till 12 noon Sept. 5. After this by ourselves until 12 noon, Oct. 17, when the instrument was moved to the city office where the remainder of the data was obtained.

From Sept. 5 to Oct. 17, the readings are from noon to noon. The other readings are from midnight to midnight.

**12 hours from 12 midnight of the 5th.

†12 hours from 12 noon of the 16th, to 12 midnight.

INDEX.

EXPLANATION OF THE PLATES.

PLATE I.—The continuous red lines represent the mean monthly temperature of the soil at different depths, 3 inches, 6 inches, 12 inches, 24 inches, for 1887, for the hours of 7 A. M., 1 P. M., 7 P. M. The black dotted lines refer to the same data for 1886.

PLATE II.—Fig. A., see also page 205, shows diagramatically the temperature of the loam soil of the cotton field and of some of the same soil kept saturated. The unbroken red lines refer to the loam and the black dotted lines to the wet soil. There was no 24-inch thermometer in the saturated soil, so the temperature at that depth is *assumed* to be the same as for the loam so as to complete the figure.

Fig. B., see also page 192. The unbroken red lines refer to the loam and the black dotted lines to the "fresh land." The temperature of the "fresh land," 24 inches deep, is *assumed* to be the same as for the loam to complete the figure.

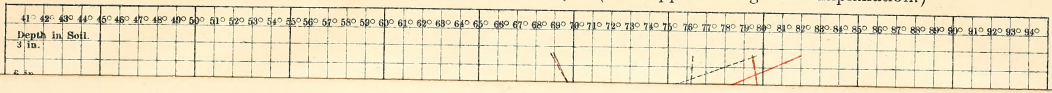
Fig. C., see also page 188. The unbroken red lines refer to the loam and the black dotted lines to the clay. We had no 24-inch thermometer at this time, so the temperature at that depth, *in both cases*, is *assumed* to be 62° so as to complete the figure.

Fig. D., see also page 186. The unbroken red lines refer to the loam and the black dotted lines to the clay. The temperature of the clay 24 inches deep is assumed to be the same as the loam.

NOTE.—We have found the temperature of all our soils to be practically the same 24 inches below the surface, and as we have only had one 24-inch thermometer most of the time, we have assumed that this is so to complete the figures.

SOIL TEMPERATURE CURVES.

PLATE I. MEAN MONTHLY TEMPERATURE, 1886 AND 1887. (See Opposite Page for Explanation.)



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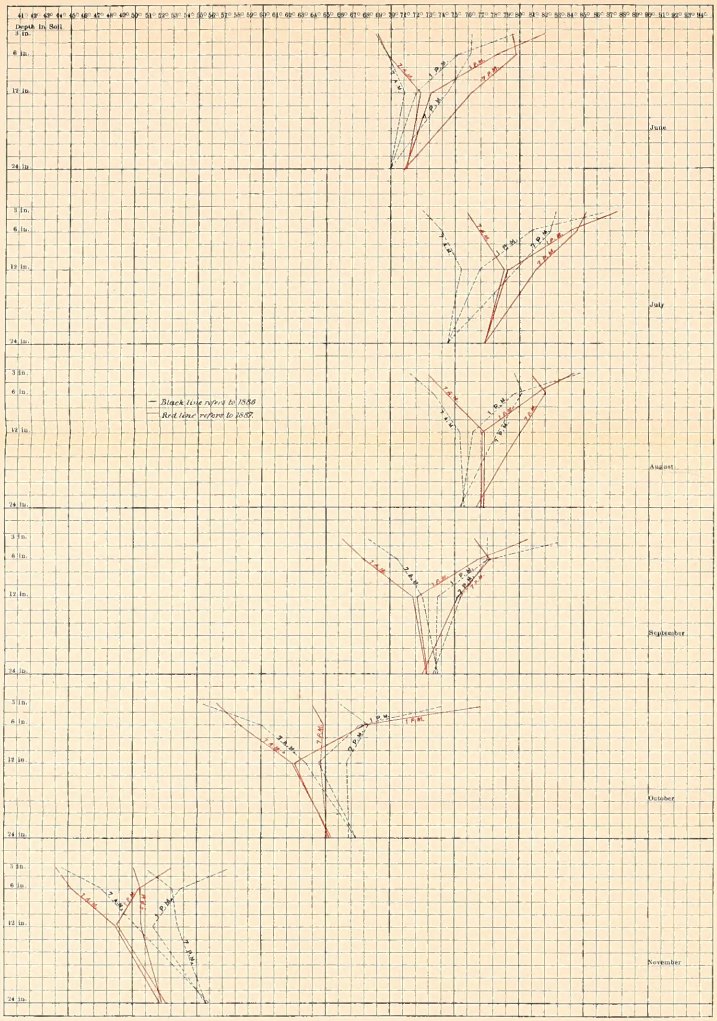

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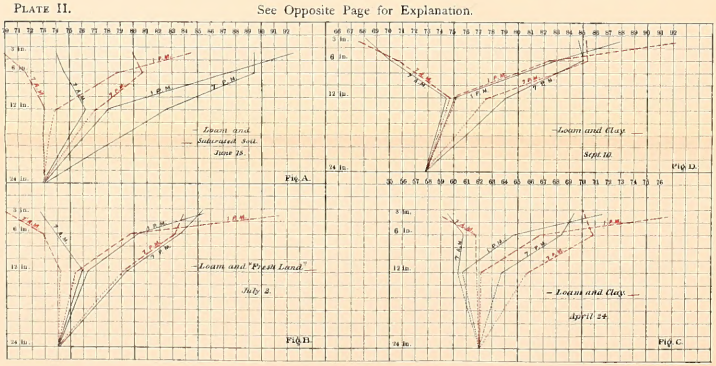

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